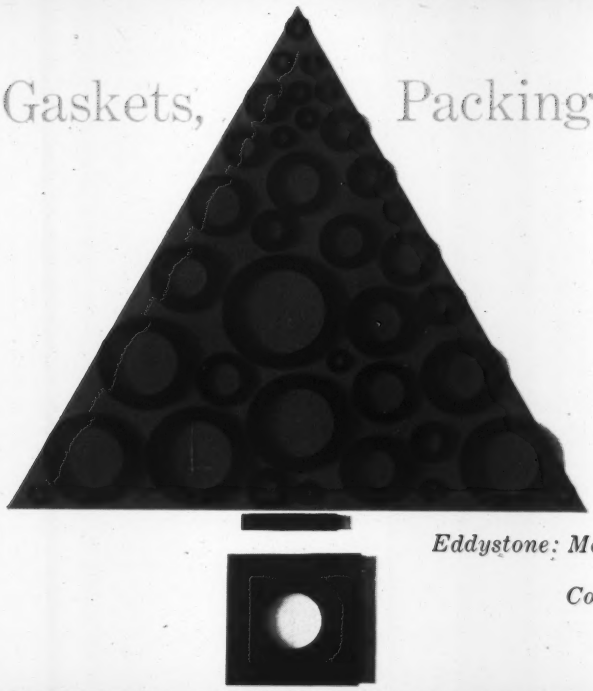
Materials in Design Engineering

FORMERLY MATERIALS & METHODS

SELECTION & USE OF METALS, NONMETALLICS, FORMS, FINISHES

Materials for Gaskets, Packings and Seals

Manual No. 165



Also: Fiber Metallurgy

Eddystone: Metals at 1200 F / 5000 Psi

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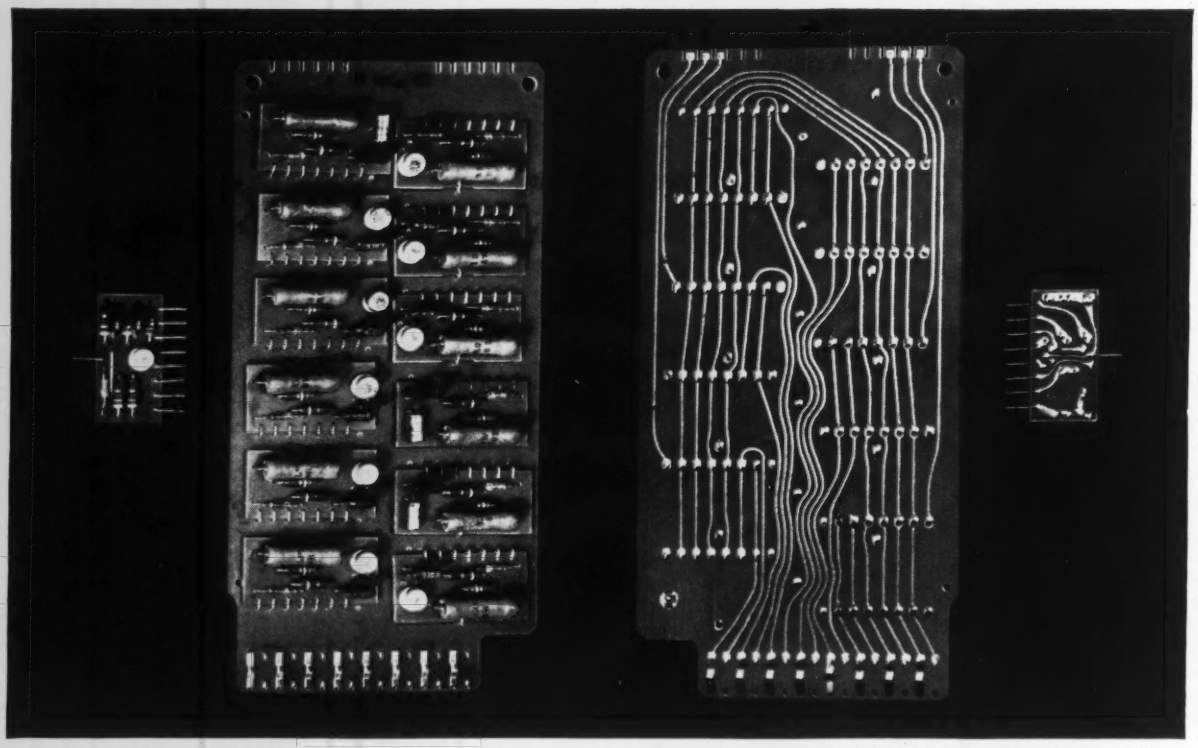
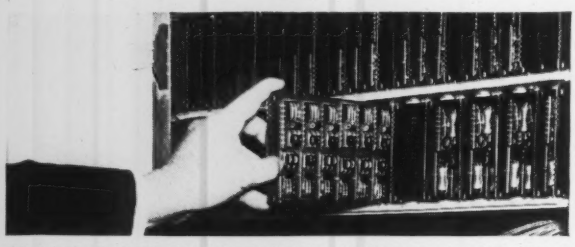
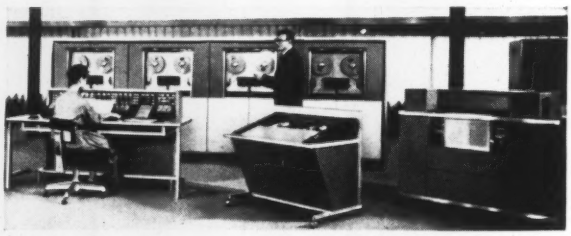


In the electronic logic elements of the RCA "501" data processing system, transistors and other small components are mounted on plastic wafers with printed-circuit wiring (small units right and left, above). The wafers, in turn, are mounted on thin plastic boards, also with printed circuits (center, above). This modular construction reduces size of the system by 75%, increases reliability, reduces maintenance.

PRINTED CIRCUITS OF COPPER AND ALL-TRANSISTOR DESIGN HELP MAKE 75% SIZE REDUCTION IN RCA DATA PROCESSOR



Modularized circuit elements are installed in the system by sliding them in place. Contacts on outside edge make possible quick checkout and testing without removing boards. Many thousands are used in each system.



The "501" is designed to handle paper work—bills, reports, payrolls, etc.—accurately, economically, and at extremely high speed. It serves businesses ranging from banks and utilities to steel mills.

With the growing importance of miniaturization and reliability in electronics and nucleonics, Anaconda electrical copper products take new and varied forms—find new and more sophisticated uses.

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Materials
in Design Engineering. *formerly Materials & Methods*

Selection & use of metals, nonmetallics, forms, finishes

DECEMBER 1959
VOL. 50, NO. 7

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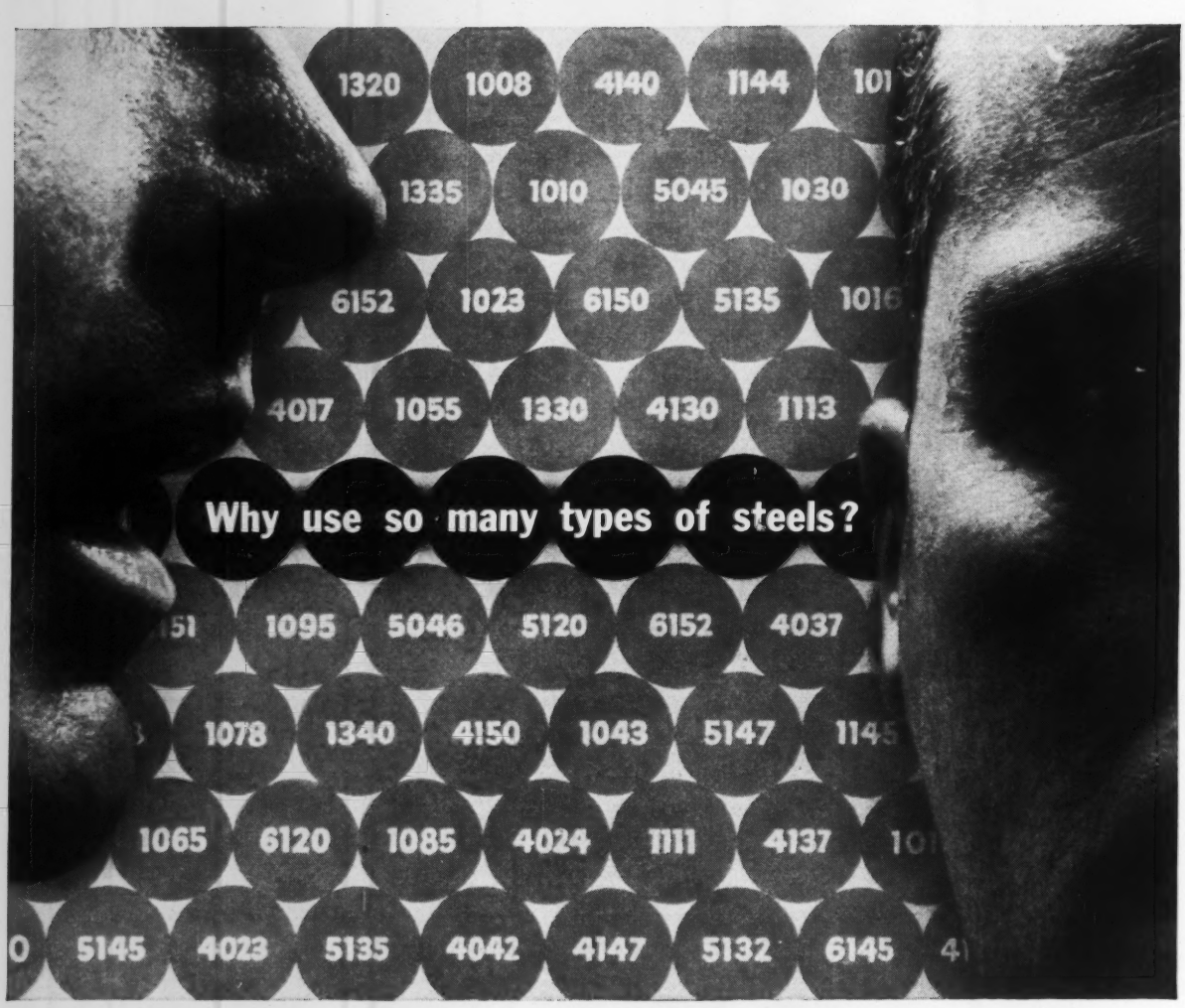

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What's new IN MATERIALS

...AT A GLANCE

New coatings and resins highlighting this year's Paint Industries Show include: 1) a 100% solids, solvent-free epoxy coating that can be applied with conventional spray equipment; 2) one-coat appliance enamels that are said to be superior to conventional two-coat systems; 3) a low cost epoxy-bituminous coating for metal and concrete surfaces; 4) solid epoxy resins for improving the mechanical and heat resistance properties of fluidized bed coatings; and 5) a fast drying alkyd resin. (Watch for more details next month.)

Better and more economical forgings may be realized with a new "hot die" forging technique that uses a nickel-base alloy die heated to 1600 F. According to the developer, thin sections are more easily formed, and precision and intricacy are markedly better than in standard forgings. Machining of parts after forging is greatly reduced.

Source: P. R. Gouwens, Armour Research Foundation, Illinois Institute of Technology, 35 W. 33rd St., Chicago 16.

A black glass that is impervious to light has been developed for enclosing silicon semiconductor devices. The glass is said to filter out virtually all wavelengths of the ultraviolet, visible and near infrared spectrum. The glass is supplied in the form of beads and cases.

Source: Corning Glass Works, Corning, N. Y.

Metal parts can be cleaned and phosphatized in one operation with a new dry process that uses a trichloroethylene-base phosphatizing solvent. The developer says the method requires no drying facilities, and occupies much less floor space than conventional aqueous cleaning and phosphatizing systems now in use. The new method, which can be used on steel, aluminum, magnesium and zinc, will be commercially available in mid-1960.

Source: E. I. du Pont de Nemours & Co., Inc., Electrochemicals Dept., Wilmington 98, Del.

A new family of high strength 25% nickel steels has been developed. Not yet commercially available, the steels are said to have yield strengths exceeding 250,000 psi, with elongations ranging from 6 to 10%. Many of the new steels are also said to have excellent cold forming characteristics after annealing. They are weldable in the hardened condition without preheating, and can be produced in bars, plate, sheet and tubing. In addition to nickel, the steels contain titanium and/or aluminum, carbon, silicon, manganese and iron.

Source: International Nickel Co., Inc., 67 Wall St., New York 5.

An improved Viton fluoro-elastomer is said to have increased resistance to high temperatures and to certain solvents, oils and chemicals. Tests show it has better retention of elongation and less change in hardness at temperatures from 500 to

600 F than conventional Viton. Other tests show good resistance to sodium hydroxide and nitric acid at 158 F, as well as to red fuming nitric acid and glacial acetic acid at room temperature. (More details in a forthcoming issue.)
Source: E. I. du Pont de Nemours & Co., Inc., Elastomer Chemicals Dept., Wilmington 98, Del.

Rare earth metal parts may be easier to produce with powder metallurgy techniques. This is the opinion of one company which is now supplying rare earth powders in any size down to –325 mesh in purities of 99.5 to 99.9%. Another company is taking the extrusion approach, and to date has successfully hot extruded yttrium metal into tubing and other shapes.
Sources: Ronson Metals Corp., Cerium Metals & Alloys Div., 45-65 Manufacturers Pl., Newark 5, N. J. (powders), and Bridgeport Brass Co., 30 Grand St., Bridgeport 2, Conn. (extrusions).

A new plastic resists a Mach 4 blast environment under very high pressures and temperatures. A tri-ester polymer, the material shows promise as an ablative coating on missile nose cones operating in the temperature range of 500 to 8000 F. The resin is still in the development stage.
Source: Raytheon Co., Plastics Div., Box 25, Great Rd., Maynard, Mass.

What is claimed to be the first commercial columbium forging was featured at the recent Metal Show in Chicago. The forging, which measures 8 in. o.d. by 6 in. i.d. by ¾ in. thick, was made of "commercially pure" arc-melted columbium. Most previous work on columbium forgings has been with ultra pure metal.
Source: Union Carbide Metals Co., Div. of Union Carbide Corp., 30 E. 42nd St., New York 17.

A new silicone varnish that cures at relatively low temperatures (300 F) is said to eliminate the need for high temperature curing ovens. The varnish is also said to have better thermal and electrical properties, and longer shelf life, than conventional silicone impregnating varnishes.
Source: General Electric Co., Silicone Products Dept., Waterford, N. Y.

High quality, induction-melted titanium has been produced by a new technique that uses a water-cooled copper crucible. The method, still under development, produces metal in a single melt, as compared to the consumable-electrode process which usually requires two melts. The developer says the experimental process can be used to continuously melt and cast all types of metal, including scrap.
Source: G. H. Schippereit, Battelle Memorial Institute, 505 King Ave., Columbus 1, Ohio

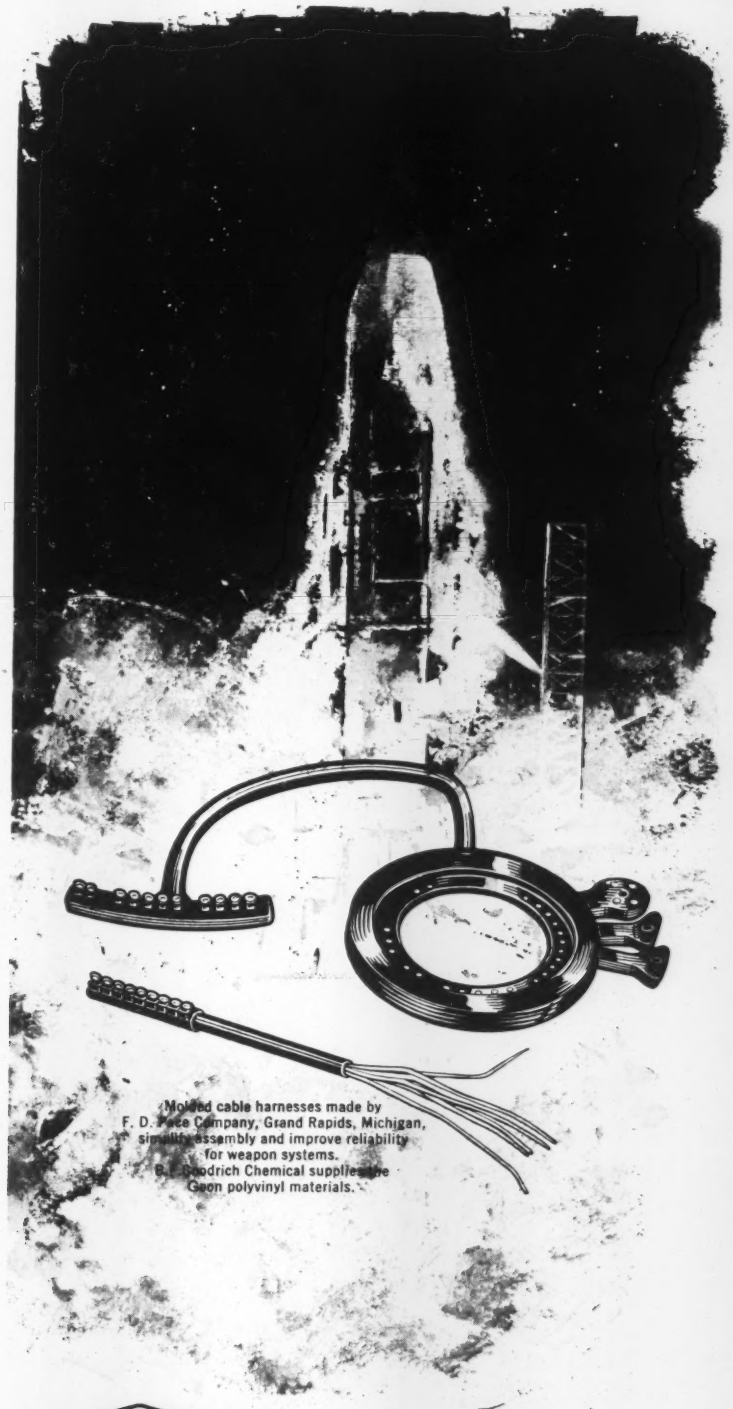
Electrostatic painting of wood is now possible. A conductive primer is applied first, and parts to be coated are grounded electrically by conveyor hangers or other supports. Electrostatic finishing is said to reduce paint costs of wood products by approximately 20 to 40%.
Source: Maas & Waldstein Co., 2121 McCarter Hwy., Newark 2, N. J.

A premium-quality carburizing steel with properties meeting the strictest specifications for critical jet engine parts is now in volume production. The steel, produced by vacuum melting SAE 9310, is said to have high fatigue strength, high core hardness and high hardenability. It is available as hot rolled bars, forgings, billets, and cold drawn and centerless ground bars.
Source: Latrobe Steel Co., Latrobe, Pa.

Turn to page 131 for more "What's New in Materials"

Another new development using

B.F.Goodrich Chemical *raw materials*



Molded cable harnesses made by F. D. Pece Company, Grand Rapids, Michigan, simplify assembly and improve reliability for weapon systems. B.F.Goodrich Chemical supplies the Geon polyvinyl materials.

Molded cable made with Geon guards weapon's sensitive "nervous system"

Firing modern weapons calls for extreme reliability—especially in the maze of interconnecting electrical components. To meet the needs of these complex installations, a new method of molding wiring harness and cable with Geon polyvinyl material has been developed that promises wide application on tough industrial applications, too.

Geon has many properties which make it ideal for moldings like this. Geon resists attack by most chemicals, heat, light and fungus. Geon also makes possible the right degree of flexibility and physical strength, which means that part of the load is taken off conductors and soldered joints. Since strain cables can be molded in, space consuming clamps can be eliminated. In addition, contacts, terminals and connectors can be molded to exact position to eliminate misconnections.

Geon also permits molding in any color to simplify coding. It's another example of the many ways Geon can contribute to new products or applications. Write Dept. AR-5, B.F.Goodrich Chemical Company, 3135 Euclid Avenue, Cleveland 15, Ohio. Cable address: Goodchemco. In Canada: Kitchener, Ontario.

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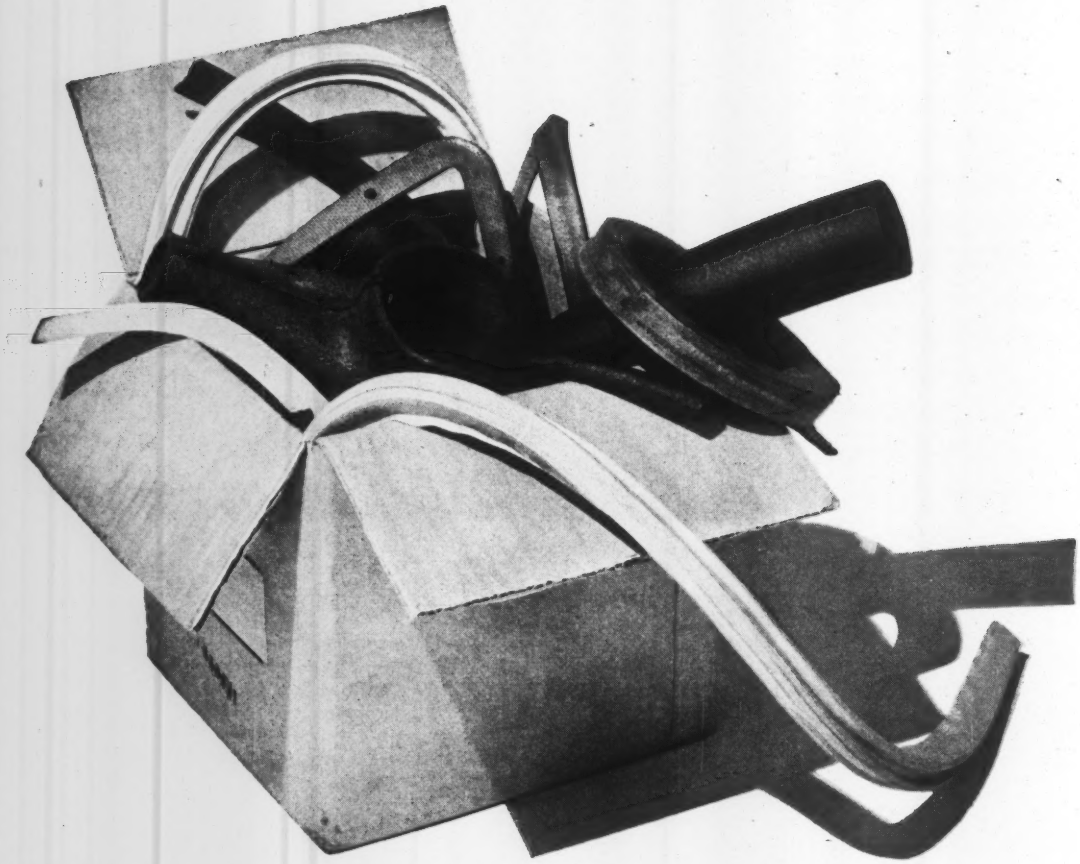

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MATERIALS AT WORK

...AT A GLANCE

Reinforced plastics used in sub conning towers

Over 1000 reinforced plastics parts are used in redesigned fairwaters (conning towers) which house essential equipment in submarines. According to the Navy, the new fairwaters, which shield the radar, sonar, radio antennas and periscope masts, can be adapted (with minor changes) to any submarine in the fleet. Reinforced plastics materials were specified because they 1) do not interfere with radar and sonar waves, 2) are corrosion resistant, 3) provide high impact strength at low weight, and 4) are easy to mold into complex shapes.

Source: Lunn Laminates, Inc.

Low carbon stainless tubing for heat exchanger

The switch from 316 stainless to 316L stainless (lower carbon content) has solved the problem of carbide precipitation and embrittlement of tubing used in aircraft heat exchangers. The tubing, whose wall thickness is only 0.005 in., was made of 316 stainless because the steel has better corrosion resistance and higher creep strength than any of the common austenitic grades. However, it failed under certain conditions. By using 316L, all the advantages of the steel are obtained with none of the disadvantages.

Source: Superior Tube Co.; heat exchangers manufactured by Garrett Corp.; used in Douglas DC-8 planes.

Vinyl film reduces infections

Thanks to an ingenious use of vinyl film, staphylococcus infections during surgery are now being reduced. The film, which is clear and about 0.002 in. thick, is used to seal off the operating wound from possible contamination by bacteria on the patient's own skin. After pre-operational cleaning, the skin is sprayed with a special "tacky" plastic material; the sterile vinyl film is then smoothed onto the body. The incision is made right through the film.

Source: Union Carbide Plastics Co., Div. of Union Carbide Corp.

Aluminum wheels cut tank weight

The Army's new battle tank, the M-60, is substantially lighter than previous models as a result of the switch to forged aluminum wheels. The wheels, said to be the first made of aluminum, are being forged by a new technique which produces ribs as an integral part of the forging. After forging and machining, a rubber tread is applied to the periphery of the wheel.

Source: Bridgeport Brass Co.

Shock absorber uses steel and rubber

A new type of shock absorber that combines the cushioning properties of rubber with the strength of steel is now available. The shock absorber consists

(continued on p 9)

Briefs

Inflatable pillows are taking the dents out of rail-shipped fruit. The pillows, consisting of a butyl rubber bladder and a neoprene-coated nylon case, replace conventional wooden bracing. When the load shifts, the pillows take up the space and prevent damage to the fruit.

Plastics landing mats are now being tested by the Army. The mats, a sandwich structure composed of glass-reinforced phenolic honeycomb core bonded to reinforced phenolic skins, have three advantages over aluminum, steel and magnesium mats: they resist fungi and corrosion, they float, and they are difficult to locate by radar.

No more squeaks—and less driver fatigue—are claimed for buses using a molybdenum-base grease. According to the bus company (which hires lady drivers), the grease not only makes driving easier, but reduces wear and repair costs.

Cow mattresses are replacing the traditional straw bedding used in cattle byres. According to the English farmer who invented the mattresses, they are less costly than straw and easier to keep clean and neat. The cows seem more contented than ever.

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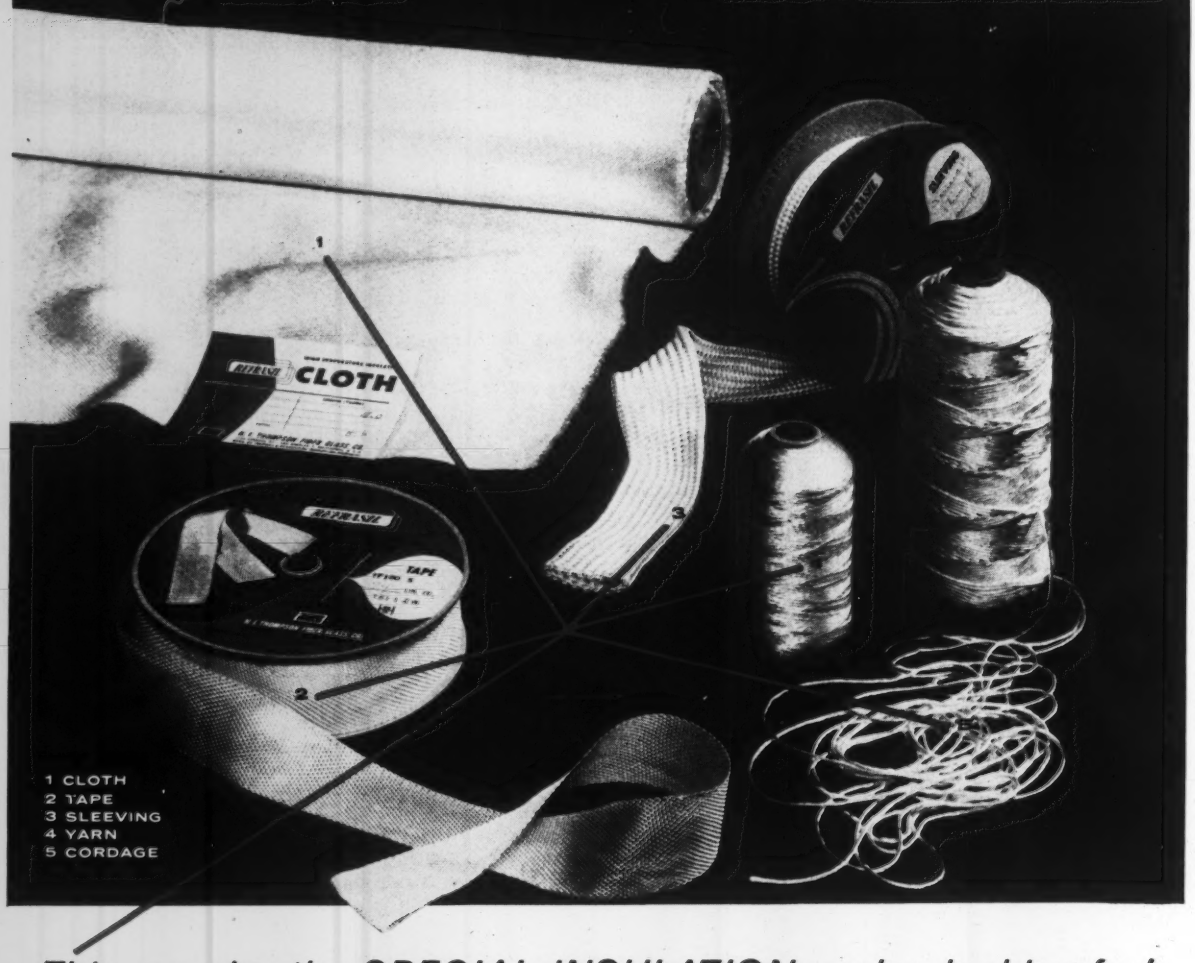

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of a special rubber compound permanently bonded to an alloy steel chain (with the links in contracted position). The design is such that the rubber is under shear, compression and tension in different sections of the shock absorber as it functions under load. The shock absorber is said to reduce maintenance and breakdowns and increase the safety factor of any type of equipment subject to sudden jerks, accelerated load fluctuations, or vibration.

Source: Brandon Equipment Co., Inc.

Huge stainless bearings for movable dome

Stainless steel bearings will play a key role in the operation of the movable dome now being built for Pittsburgh's new Public Auditorium. The 900-lb, 21-in. bearings will be built into the tips of the cantilever arms that support the dome. Self-lubricating bronze bushings will be fitted around the bearings to facilitate movement.

Source: U. S. Steel Corp.

Nylon tubing cuts cost of air control system

The change from copper to nylon has resulted in a $30,000 reduction in the installed cost of tubing used in the air control system in a new chemical plant. Advantages of nylon: light weight (one-eighth that of copper); flexibility; ability to be color coded; corrosion resistance; good impact strength at low temperatures; kink resistance; and extremely tough and abrasion resistant surfaces. Over 100,000 ft of the nylon tubing are used in the plant.

Source: Allied Chemical Corp.

Largest aluminum pipeline laid in lake

What is believed to be the largest aluminum pipeline ever made is now being installed in Lake Maracaibo, Venezuela. The 16-in. pipe, to be used as a suction line for a fire protection pump, is rolled and welded from ¼-in. plate. Aluminum alloy 5083 was selected for the 1800-ft line because its excellent corrosion resistance permits installation in the lake.

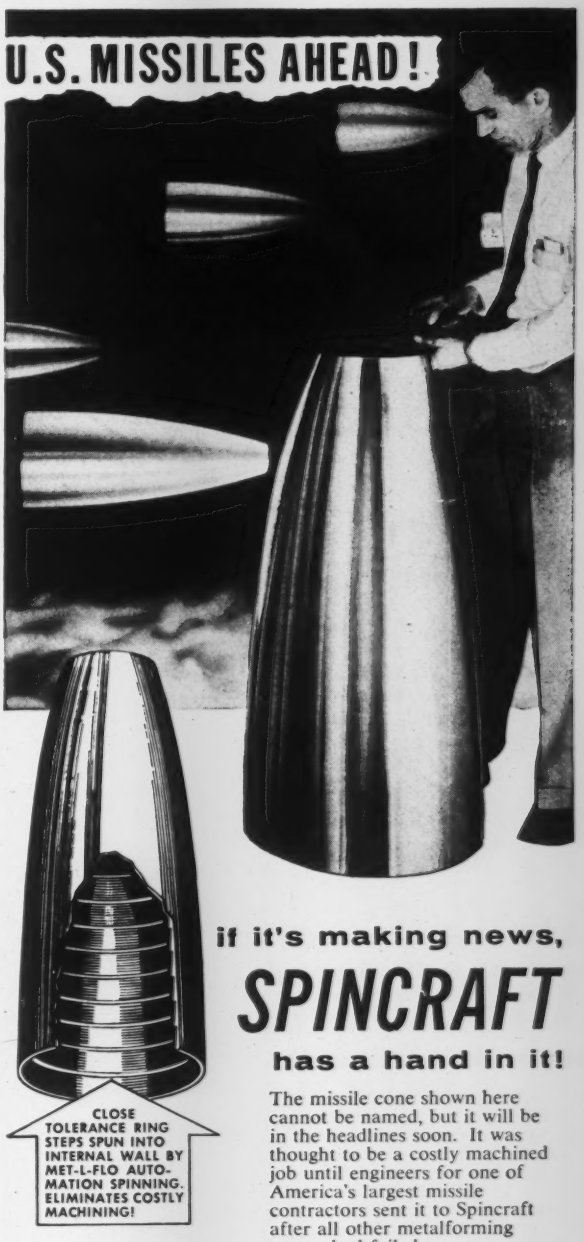
Source: Reynolds Metals Co.; pipeline fabricated by Graver Tank Corp.; used by Superior Oil Co.

Stainless hooks cut descaling cost

The change from a nickel-copper alloy to a stainless steel has resulted in a yearly saving of $1825 in the cost of pickling hooks used in a descaling operation —even though each of the stainless hooks is about $5 more expensive. The hooks are used to carry automobile crankshafts through a bath of hot sulfuric acid. The stainless hooks outlast the nickel-copper hooks by about 5 to 1.

Source: Carpenter Steel Co.; hooks used by Chevrolet Motor Div., General Motors Corp.

(more Materials at Work on next page)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if it's making news,

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The missile cone shown here cannot be named, but it will be in the headlines soon. It was thought to be a costly machined job until engineers for one of America's largest missile contractors sent it to Spincraft after all other metalforming means had failed.

Not only did Spincraft's type of metalspinning save tool and die costs; it accomplished the internal machining as well, and all on one versatile lathe of a special type available only at Spincraft. In addition, it maintained the close tolerances required.

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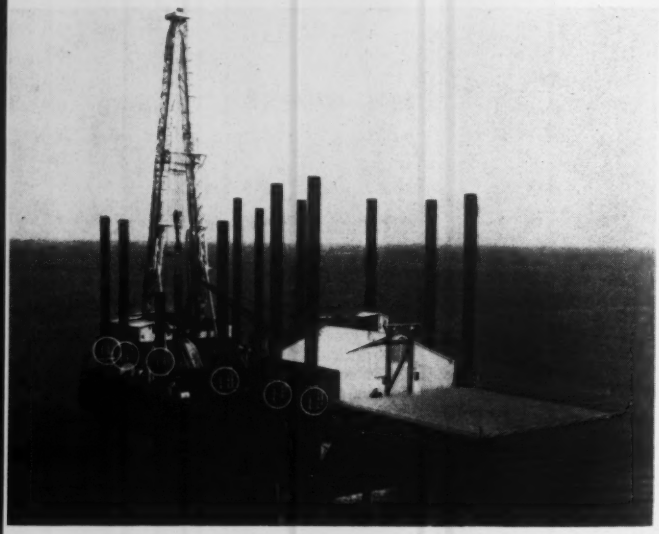
MATERIALS AT WORK

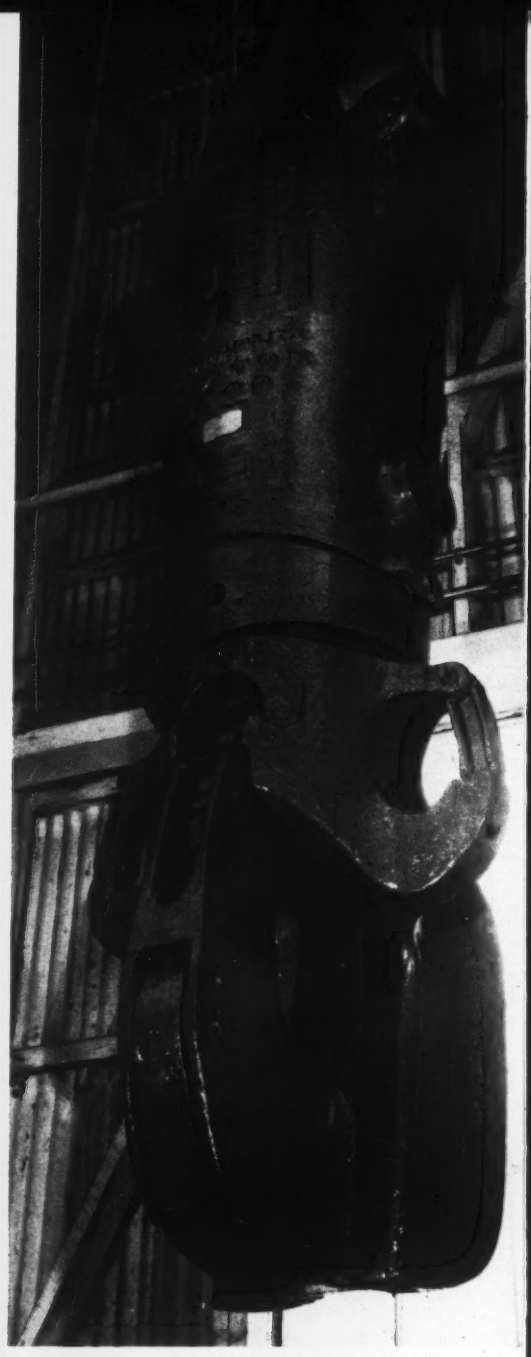
Large steel castings cut costs, improve design

Edited by Walter Lubars

The accompanying photos show some of the winning entries in the 3rd Product Development Contest recently conducted by the Steel Founders' Society of America. The primary advantage of steel castings—the production of large, economical parts with uniform properties—is well known. The parts described here show some specific ways in which steel castings cut costs, reduce weight and improve product design.

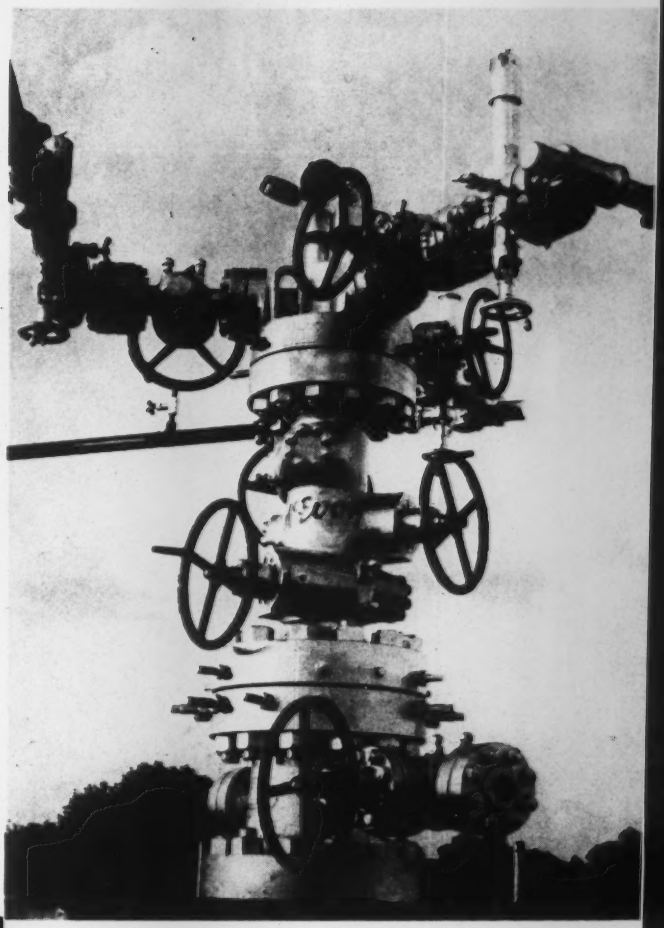
Jacking unit used to raise and lower the piling that supports offshore oil well drilling barges uses two large steel castings welded into a "bowl." The cast steel bowl assembly, consisting of an upper half weighing 3620 lb and a lower half weighing 2770 lb, replaces a previous weldment composed of several parts formed from heavy plate. Advantages of the switch are: 1) 45% reduction in overall cost (from $29,120 to $16,403); 2) earlier delivery; 3) greater accuracy; and 4) reduced finishing requirements. A new one-piece casting is now being designed.

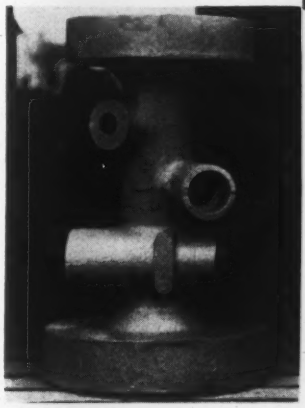




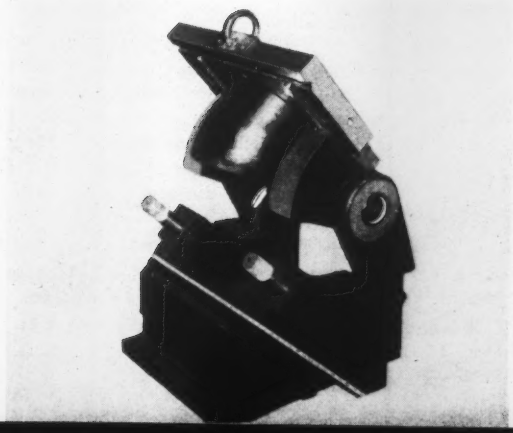
Oil well drilling hook, said to be the world's largest, is composed of 25 machined AISI 8630 and AISI 1037 steel castings. The hook, which weighs 10,000 lb and stands 11 ft, 7½ in. high, is designed to handle the tremendous loads encountered when drilling to depths of 5 miles (rated capacity of the hook is 500 tons). Steel castings were selected because they were the "only materials with satisfactory characteristics of wear resistance, fatigue life and impact resistance combined with design freedom and reasonable initial cost."

Split tee and plug, used on large pipelines to provide an entry or exit point, is composed of two steel castings. The tee is cast as a unit, split (to permit installation around pipe), and then welded together and to the pipe. The unit weighs 900 lb and has a 16-in. i.d. The cast steel plug weighs 130 lb and has a 15¼-in. o.d. According to the manufacturer, the switch from a weldment to a casting resulted in two major advantages, elimination of expensive welding, cutting, fitting and machining operations; and ability to produce thicker sections at points of high stress, thinner sections for low stress.



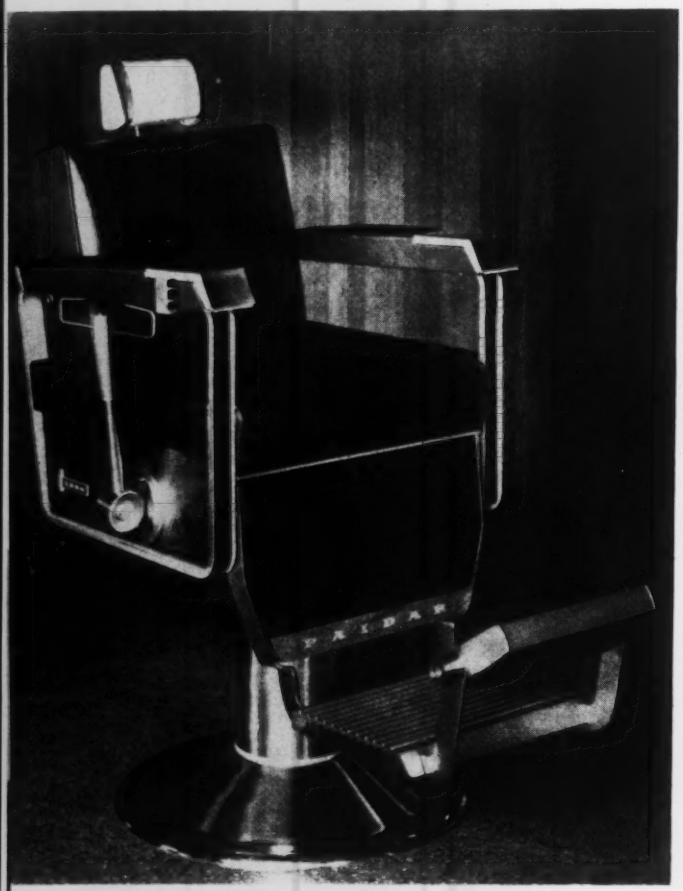


Triple valve for oil well control heads replaces three single valves previously used. The cast steel valve is 39 in. high, has a 23½-in. flange dia and weighs 1600 lb. Its pressure rating is 10,000 psi. Steel castings were selected in preference to forgings and other materials generally used for high pressure valves for the following reasons: 1) because of the valve's peculiar shape, a forging would be extremely difficult to make and would be considerably heavier; 2) the three valve cavities would have to be machined from the solid at greatly increased cost; 3) a forging die is considerably more expensive than a casting pattern; and 4) the required dimensional limitations could not be obtained any other way.



Pipe bending die, used to produce 45-deg cold compression bends in 12¾-in. o.d. pipe, consists of three AISI 4335 steel castings. The die was previously made of plate and wrought sections welded and bolted together. Advantages of the change to steel castings: 1) weight reduction of approximately 65%; 2) reduction in machining time of about 75%; 3) increased impact strength (die withstands 700-ton shock loading); 4) increased wear resistance of polished inner cavity; and 5) minimum distortion in heat treatment as a result of uniform section thickness.

Aluminum cuts weight, cost of redesigned barber chair



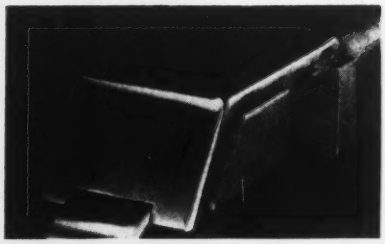
Extensive use of aluminum extrusions and machined parts is said to play an important role in the "first major change in barber chair design in over 20 years."

The new chair, manufactured by Emil J. Paidar Co., was designed to be attractive, inexpensive and lightweight. According to Paidar, the new chair is half the weight of traditional chairs, about 10% cheaper, and just as sturdy and dependable.

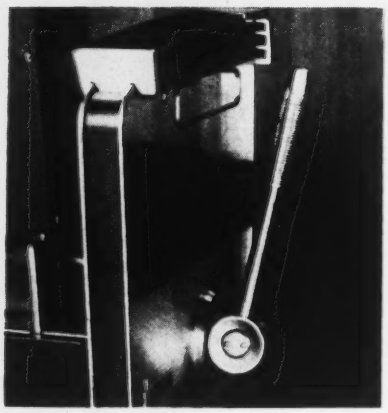
Aluminum parts used in the redesigned chair include: foot rest, platform, arm supports, handle for raising and lowering the chair, and tray support.

The aluminum, supplied by Kaiser Aluminum & Chemical Corp., is fabricated into components by Bohn Aluminum & Brass Corp.

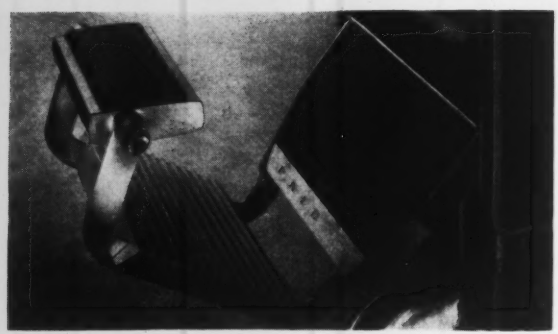
(more Materials at Work on p 189)



***Arm supports** and fixture for trays are aluminum extrusions.*



***Handle** that controls tilt and vertical movement is made of aluminum rod with machined grip.*



***Foot rest** is heavily anodized aluminum extrusion.*

MORE MATERIALS AT WORK

Acrylic models 189

Zinc alloy dies outlast steel dies 190

Filled nylon sleeves cut maintenance costs 190

Cold drawn stainless solves tubing problems 192

Polyethylene wheels polish metal samples 194

Pyroceram mirrors in airborne telescopes 196

Largest magnet 198

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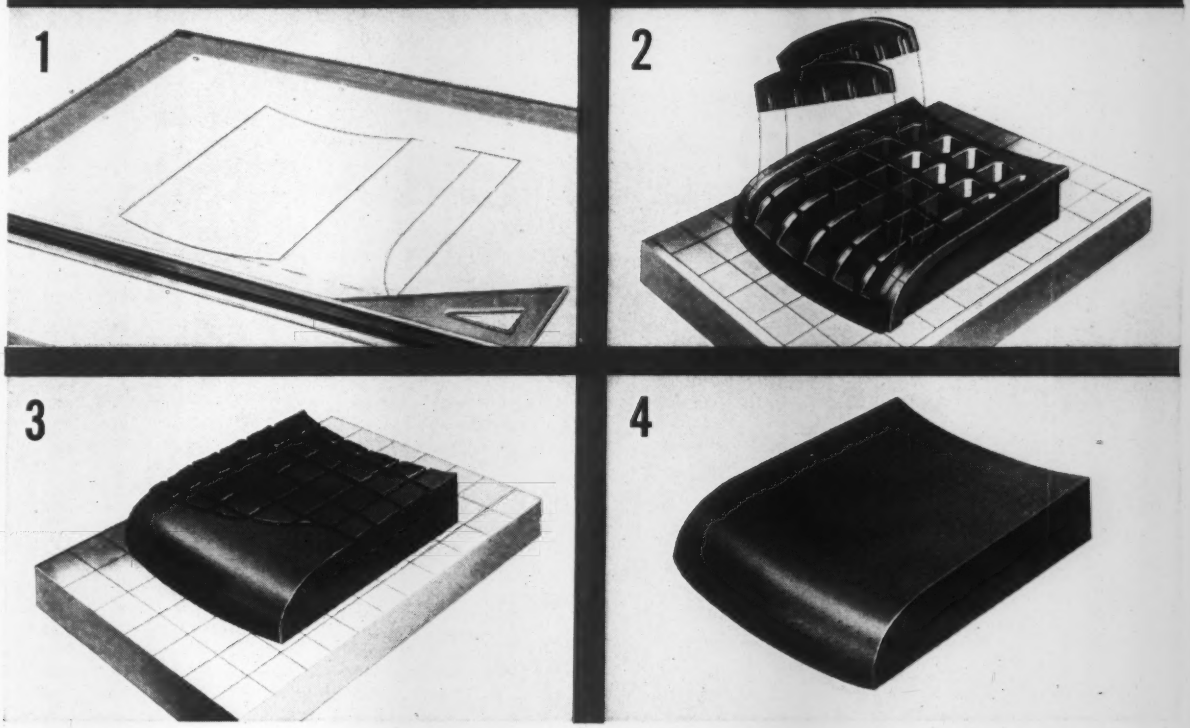

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(4) The finished model is grain-free, dimensionally stable, and unaffected by moisture and weather. It will not chip or deteriorate with age and can be altered simply by bonding additional Epotuf-based material on the model.

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**Complete information on the Kish System is available from Kish Industries, Inc., 1301 Turner Street, Lansing 6, Michigan.*

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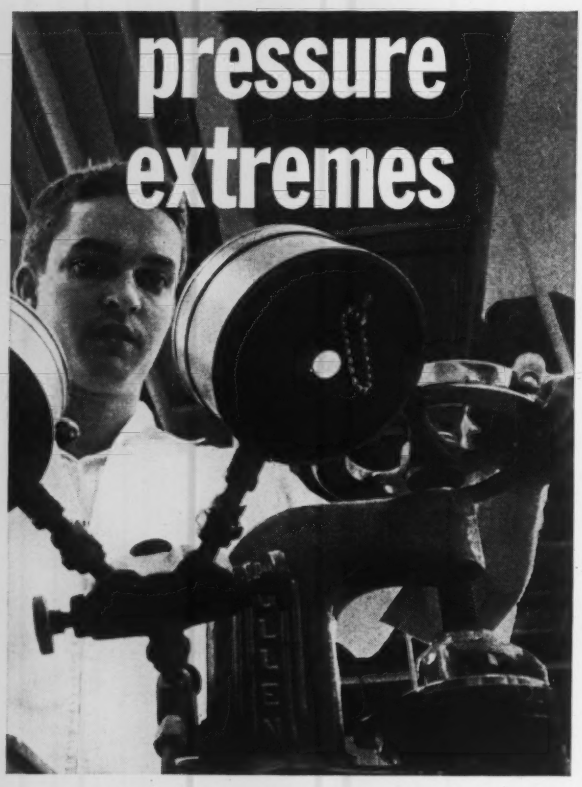

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SAMPE—pro

To the Editor:

Thank you for your excellent rebuttal to Mr. F. L. LaQue's dissent on the Society of Aircraft Materials & Process Engineers (M/DE, Oct '59, pp 249 and 250).

The third paragraph of your editorial entitled, "Can existing societies do the job?", is perhaps the most directly pertinent part of the rebuttal. With all due respect to NACE, AWS, ASM, MSPE, SPE, ASTM, AIChE, AIEE and others, there is no single organization in the land that will fulfill the technical needs and desires of the Aircraft Materials and Process Engineer. Although many of the problems and interests are basic and are not peculiar to aircraft, it is the diversification of the Materials and Process engineer which necessitates the SAMPE Organization.

Mr. LaQue indicates that SAMPE is a highly specialized organization whose objectives could best be served by existing societies. We believe that the opposite is true. It is because of the high degree of specialization of such organizations as AWS, SPE and ASM that the need for SAMPE exists.

After all the arguments are in, pro and con, we sincerely hope that Mr. LaQue will be counted as an active supporter of SAMPE.

R. A. WENNEKER,
Chairman, St. Louis SAMPE
St. Ann, Mo.

SAMPE—con

To the Editor:

With reference to the Society of Materials and Process Engineers, it is true that this may be as necessary as the Society of Military Engineers, the Society of Heating, Ventilating and Air Conditioning Engineers, and some other organizations.

However, societies tend to be like standards and specifications. Relatively few men are willing to accept completely any standards or specifications which have been made up by anyone else. Many men have taken the ASME Code and rewritten it (just changing a word here and a paragraph there) sufficiently to claim authorship of a new construction code. We have the ASME Code, in turn, taking ASTM material specifications, adding a letter to the designation, and, in some cases, changing a word or a figure in the specifications so that they become ASME specifications.

In the same way, be there an engineer with soul so dead that he is not convinced that his job is different from anyone else's job; that his industry is different from anyone else's industry; that he has discovered a new branch of engineering which needs recognition and national organization?

In my opinion, Frank LaQue is one of the most

Salt River Valley Water Users Association,
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Saves $699.00 per pump...

by using ground and polished

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made by elevated temperature drawing process

The men who operate the "Salt River" project have the job of supplying water to 240,000 acres of land in Arizona, where the Gila River joins the Salt River. The Association maintains some 250 deep well pumps to help supply the required water.

Richard Juetten, Supervisor of Salt River's Pump Division, reports that the use of La Salle FATIGUE-PROOF steel bars has permitted a saving of $699.00 per pump . . . a potential saving of $174,750 when applied to the 250 pumps now in operation.

Mr. Juetten's report follows:

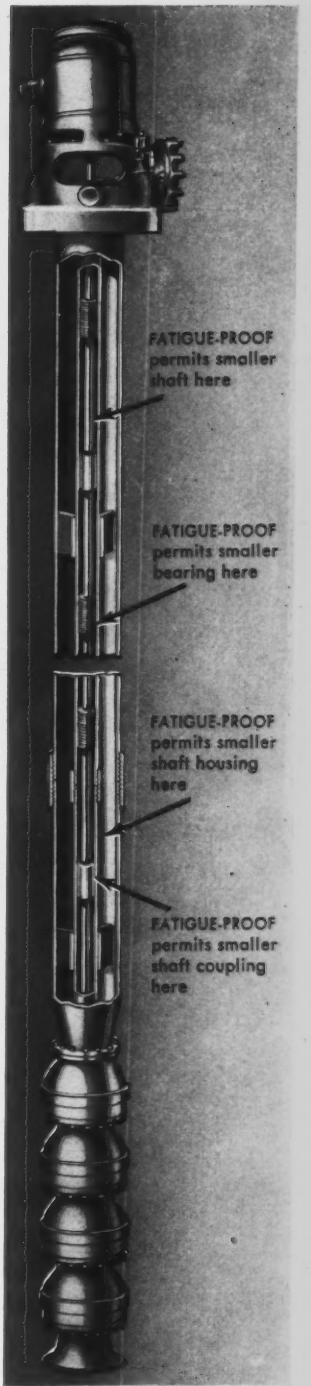
"I have figured our direct saving realized by using La Salle FATIGUE-PROOF steel bars in place of standard C-1045 steel shaft in our deep well turbine pumps.

"FATIGUE-PROOF enables us to use bars only $1\frac{11}{16}$" in diameter . . . instead of $2\frac{3}{16}$" diameter shafts which were necessary when we used C-1045 . . . and this despite higher horsepower, more weight, and additional pump bowl assemblies.

"Here are comparative costs per 10-foot section (of a 300-foot pump shaft):"

using C-1045		using FATIGUE-PROOF	
10' x 2-3/16" dia. shaft	$28.30	10' x 1-11/16" dia. FATIGUE-PROOF	$22.59
3½" shaft housing	26.30	3" shaft housing	19.80
2 bearings, 3½" x 2-3/16"	21.72	2 bearings, 3" x 1-11/16"	13.46
Shaft coupling	5.16	Shaft coupling	2.34
TOTAL cost	$81.48	TOTAL cost	$58.19
Cost per foot	$ 8.15	Cost per foot reduced to	$ 5.82

RESULT: A saving of $2.33 per foot . . . or $699.00 when applied to a 300-foot pump setting. And this doesn't take into consideration reduced power consumption.


FATIGUE-PROOF permits smaller shaft here
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FATIGUE-PROOF permits smaller shaft housing here
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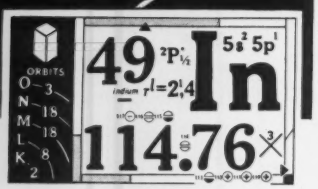

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intelligent and capable authorities on metals.

Without even knowing what a process engineer, as covered by this particular designation, may be, I will give Frank full and enthusiastic agreement.

F. W. EMHARDT
Chief Engineer
Struthers Wells Corp.
Warren, Pa.

Property data centers

To the Editor:

It was with considerable interest that I read your editorial, "Do We Need Property Data Centers?" in M/DE, Sept '59. You may be interested to know that Wright Air Development Center has published a WADC Technical Note 58-192, *Materials Information Centers*, by Lt. Col. M. E. Fields and D. H. Cartolano, Materials Laboratory, WADC '58. Descriptions of more than one hundred information centers are provided in this report.

Quite a number of these materials information centers have been in existence for many years. Our own organization, the Prevention of Deterioration Center of the National Academy of Sciences, National Research Council, was established in 1945, and was the outgrowth of the wartime Tropical Deterioration Information Center. Our group is sponsored and funded by the Army, Navy, and Air Force by means of a contract between the Office of Naval Research and the National Academy of Sciences. As the name of our organization suggests, we are an information, consultant, and publications group in the field of deterioration and its prevention as it pertains to materials and equipment used by the Armed Services of the United States.

If the existence of these information centers was more widely publicized, they would be used to a much greater extent.

C. J. WESSEL, Director
Prevention of Deterioration Center
National Academy of Sciences
Washington 25, D. C.

Our editorial was a plea for more centers that are property-oriented. While we highly recommend to our readers the WADC list mentioned by Mr. Wessel, few, if any, of the organizations listed are the type of world-wide property centers we had in mind.

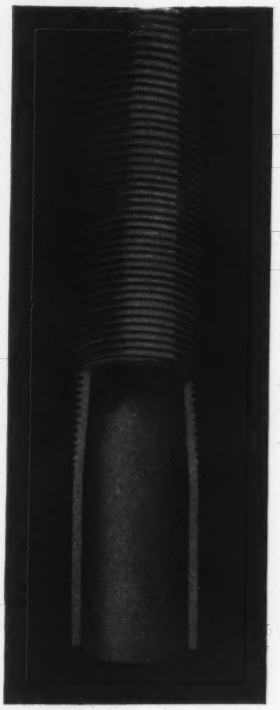
Magnet material correction

To the Editor:

Your article, "Permanent Magnet Materials," July '59, p 108, is very complete although there is one typographical error—Alnico XII contains 35% cobalt, not 3.5%. Also, the value of coercive force which you give for Silmanal, 6300, is the intrinsic value, I believe . . .

W. E. MCKIBBEN
Euclid, Ohio

The corrections are valid.



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Gateway Center, Pittsburgh, Pa.

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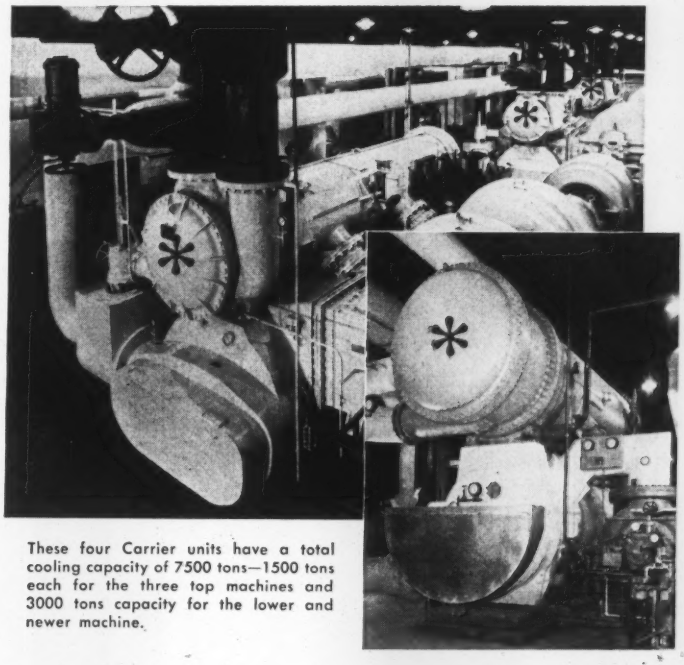

These four Carrier units have a total cooling capacity of 7500 tons—1500 tons each for the three top machines and 3000 tons capacity for the lower and newer machine.

Carrier engineers have high praise for Wolverine Trufin Type S/T—the integrally finned refrigeration condenser tube. They speak from experience in using Trufin in Centrifugal Refrigeration Machines for air conditioning the buildings of Pittsburgh's beautiful Gateway Center.

"The ability of Trufin Type S/T to pack a lot of heat transfer surface into a small space, helps us design refrigeration machines which require a minimum of space and weight for the required cooling capacity," say the Carrier men.

In the Gateway Center installations, more than 200,000 feet of integrally finned Trufin Type S/T, was used in the coolers and condensers of three 17M64 Carrier Centrifugal Refrigeration Machines of 1500-ton capacity each, and one 3000-ton capacity 17PM470 Carrier unit.

If your company is involved in refrigeration, air conditioning or other heat transfer applications, Wolverine Trufin Type S/T can help you do a better job—just as it does Carrier Corporation.

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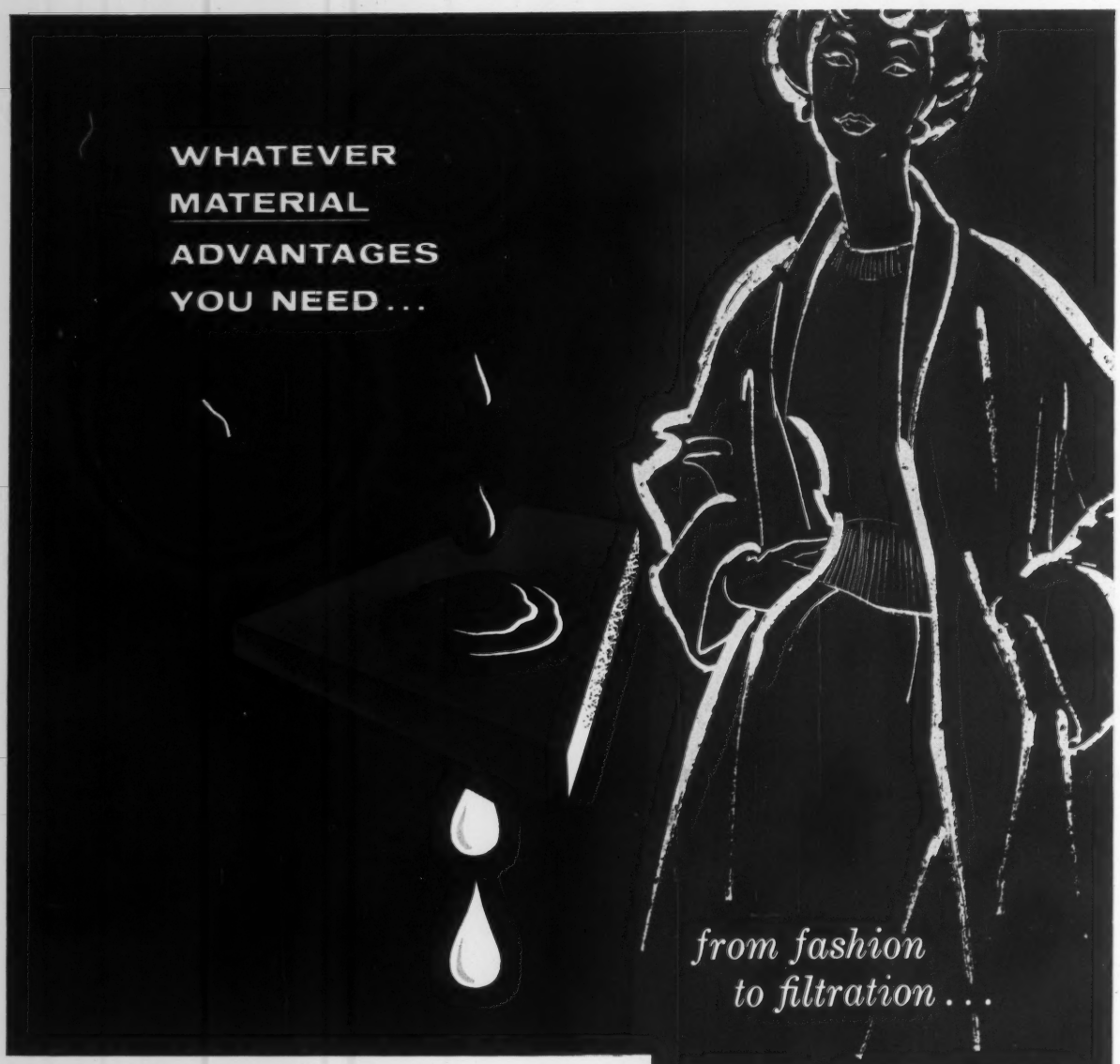

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PRICES AND SUPPLY

...AT A GLANCE

What about steel supply, now that the strike is over? The concensus of producers, consumers and government economists is that the scar will last for a long time, even if the strike is really over. Specifically: at least a month, probably two, before output is back to pre-strike levels; a 6-12 week delay on steel ordered before the strike; and a 16-20 week delay on steel ordered after the strike began.

World rubber usage will increase by 30% in the next five years, according to Dr. Frank K. Schoenfeld, research vice president, B. F. Goodrich Co. Dr. Schoenfeld's prediction is based on the fact that world rubber demand has been increasing at a rate of 4½% per year. By 1965, world consumption will reach 4.6 million long tons.

Production and use of synthetic rubber will probably show the most startling gains. According to Dr. Schoenfeld, consumption of synthetic rubber will increase by 60% in 1965. World production capacity (not including Communist countries) is expected to double in the next three years to about 670,000 tons. The ratio of synthetic to natural rubber usage is expected to climb in the United States from the present 65% to about 75-80% by 1965. Free world ratio is expected to increase to about 45%.

Steel production will break all records in 1960, according to Charles M. White, board chairman, Republic Steel Corp. Mr. White says that total steel output will climb to about 120-130 million tons. The previous record, set in 1955, was 117 million tons.

A 50% expansion of vinyl film production has been made by Goodyear Tire & Rubber Co. The expansion was necessary, according to Russel DeYoung, president, "to meet increasing demand."

Greater availability of molybdenum should result from the discovery of a huge deposit in Sardinia. According to the firm of Mazzacurati & Giacomelli, of Rome, the deposit is the second largest in the world, amounting to about 5 million tons of molybdenum metal. Percentage of molybdenum in the ore is very good—about 0.6%. First estimates give the cost of extracted molybdenum at about $1.25 per lb.

Price of palladium has been increased $4 per oz by Engelhard Industries, Inc. New price is $24 per oz.

Polyethylene production will be increased 50 million pounds per year by U. S. Industrial Chemicals Co. When expansion is complete in mid-1960, USI's total capacity will be 300 million pounds per year, making it the second largest polyethylene producer in the world.

Shortages of galvanized steel will probably continue for another year, predicts Seymour Waldman, president of Rolled Steel Corp. According to Mr. Waldman, a significant shortage existed before the steel strike and it will take about six months before industry can begin to build normal steel inventories for products other than galvanized.

That second supplier of acrylic syrup will not materialize after all. Escambia Chemical Corp. has denied the statement (published in the Sept issue of M/DE) that it plans to produce the material.

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Surface Area, sq. m/g	35	40	15	15
Oil Absorption, parts linseed oil/100 parts	180	160	80	20
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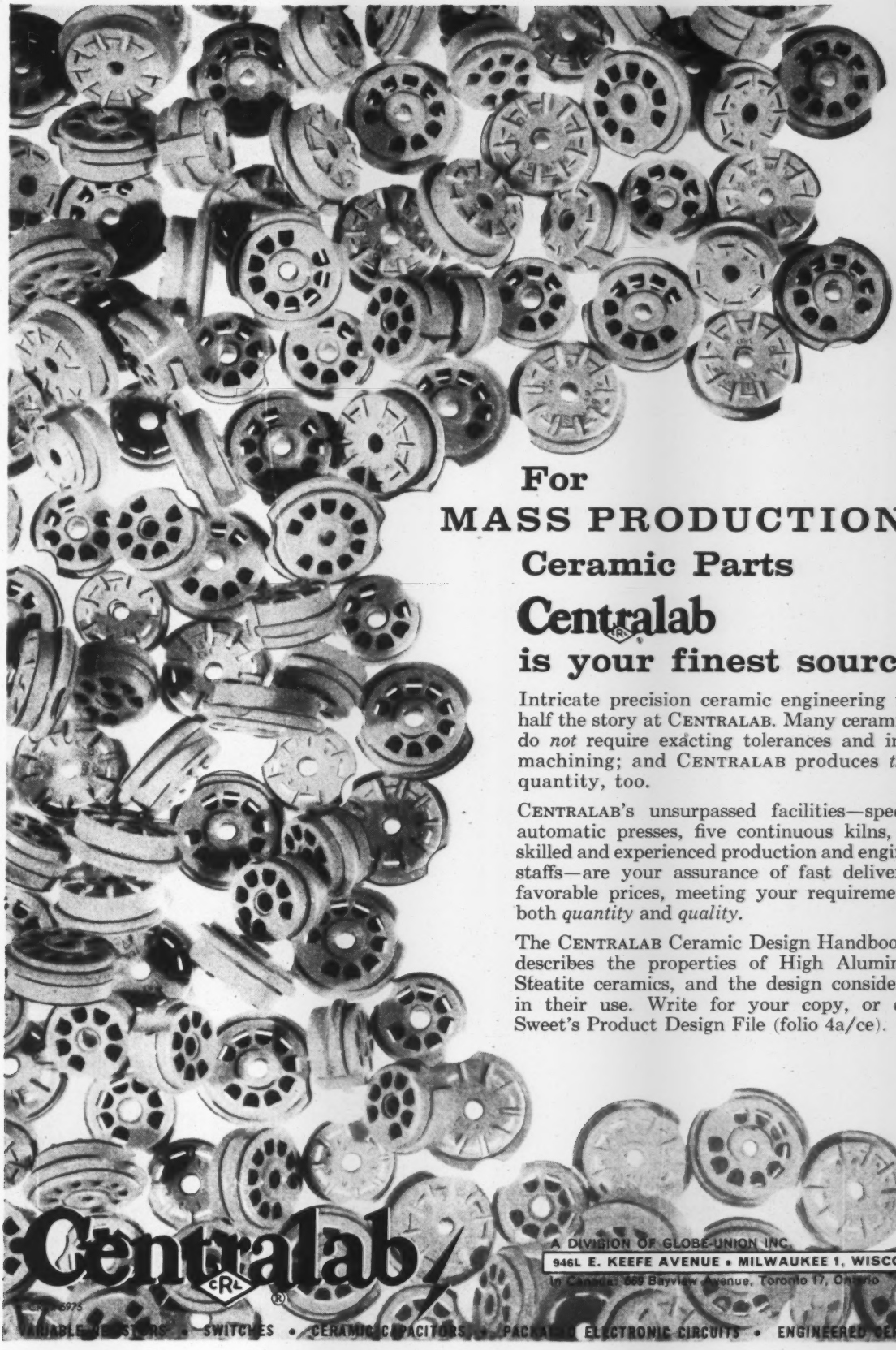
Example: In ceramics, they develop a microcrystalline structure to achieve high strength and fine texture—can be formed into complex shapes by slip-casting and pressing. As a reinforcing agent, they offer advantages in oxide-strengthened metals and in plastics and synthetic elastomers.

Monsanto researchers have turned out numerous micro-fine oxides of various metals—can produce pilot-plant quantities in dense or laminar forms. Today four MICRIA products (see table) show outstanding commercial promise. To benefit from a ground-floor "speaking" acquaintance with them, write for samples and technical data.

For more information, turn to Reader Service card, circle No. 380



For MASS PRODUCTION Ceramic Parts

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Intricate precision ceramic engineering is only half the story at CENTRALAB. Many ceramic units do *not* require exacting tolerances and intricate machining; and CENTRALAB produces *these* in quantity, too.

CENTRALAB's unsurpassed facilities—specialized automatic presses, five continuous kilns, highly skilled and experienced production and engineering staffs—are your assurance of fast delivery and favorable prices, meeting your requirements for both *quantity* and *quality*.

The CENTRALAB Ceramic Design Handbook fully describes the properties of High Alumina and Steatite ceramics, and the design considerations in their use. Write for your copy, or consult Sweet's Product Design File (folio 4a/ce).

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A DIVISION OF GLOBE-UNION INC.
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VARIABLE RESISTORS • SWITCHES • CERAMIC CAPACITORS • PACKAGED ELECTRONIC CIRCUITS • ENGINEERED CERAMICS

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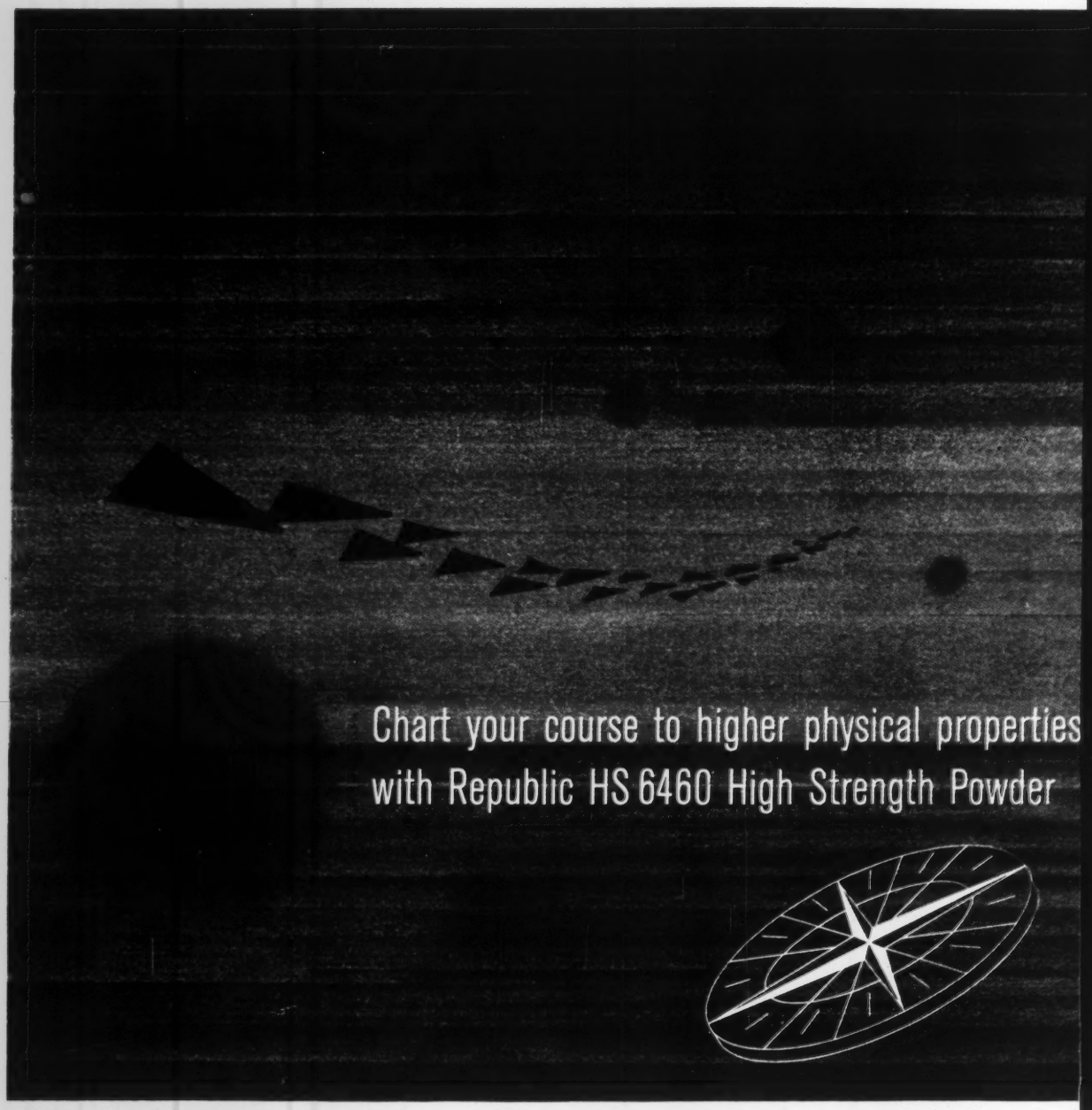
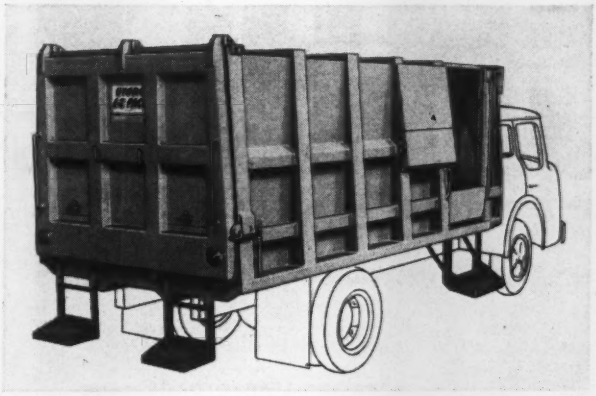


Now you can produce *higher strength, higher stressed* parts on existing production equipment with Republic HS6460 High Strength Powder.

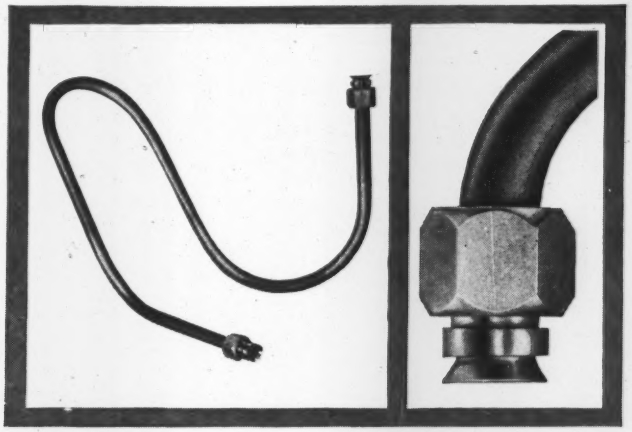
HS6460 is a soft, alloy powder with excellent compressibility. It makes possible higher tensile strengths than ever before achieved with ferrous powders. Provides a minimum tensile strength of 60,000 psi at 6.4 density as sintered —100,000 psi after heat treatment. Excellent carbon compatibility enhances its ability to be heat treated.

HS6460 can be used for comparable strength structural parts at lower manufacturing costs than obtainable with copper infiltration. Additional production economies can be obtained because fewer operations will be required to obtain high density, high strength parts.

For technical data on HS6460 High Strength Powder, including fatigue and impact test results, mail the coupon.



HIGH STRENGTH STEEL SOLVES WEIGHT PROBLEM in Hydro E-Z Pack enclosed truck bodies, manufactured by Hercules Galion Products, Inc., Galion, Ohio, for haulers of refuse and garbage. Tough, strong, lightweight Republic "50" High Strength Steel allows an E-Z Pack unit to be carried on a chassis as small as a two-ton truck. Reduced weight permits increased payload—fewer trips to the dump. High Strength Steel withstands the heavy compressive force of packer blades, allows tight compaction of loaded materials. Long, dependable service is assured by high resistance to the corrosive and abrasive action of refuse. Write for full facts on Republic High Strength Steel.



CONSISTENTLY HIGH PAINT-HOLDING CAPACITY makes Republic Electro Paintlok® Steel Sheets ideal for (1) water cooler housings; (2) exterior panels of ranges, freezers, dryers, washers, air-conditioners, and other major appliances; and (3) cabinets for home, commercial, and industrial applications. Electro Paintlok increases die life, and permits faster fabrication, with correspondingly lower costs. May be stored for extended periods under approved warehouse conditions. Send coupon for more facts.

REPUBLIC ELECTRUNITE® HYDRAULIC FLUID LINE TUBING SOLVES FAILURE PROBLEM resulting from longitudinal or transverse cracks. No failure from these causes has ever been reported in the history of the product. ELECTRUNITE gives you more tube per dollar. It provides utmost uniformity, assures better bending and flaring, offers appreciable savings in downtime. Available in all sizes shown in JIC Standards Book, and meets the requirements of SAE Standards. Mail the coupon for complete information.

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1441 REPUBLIC BUILDING • CLEVELAND 1, OHIO

Send more information on:

☐ HS6460 High Strength Powder
☐ ELECTRUNITE Hydraulic Line Tubing
☐ High Strength Steel ☐ Electro Paintlok

Name_____ Title_____

Company_____

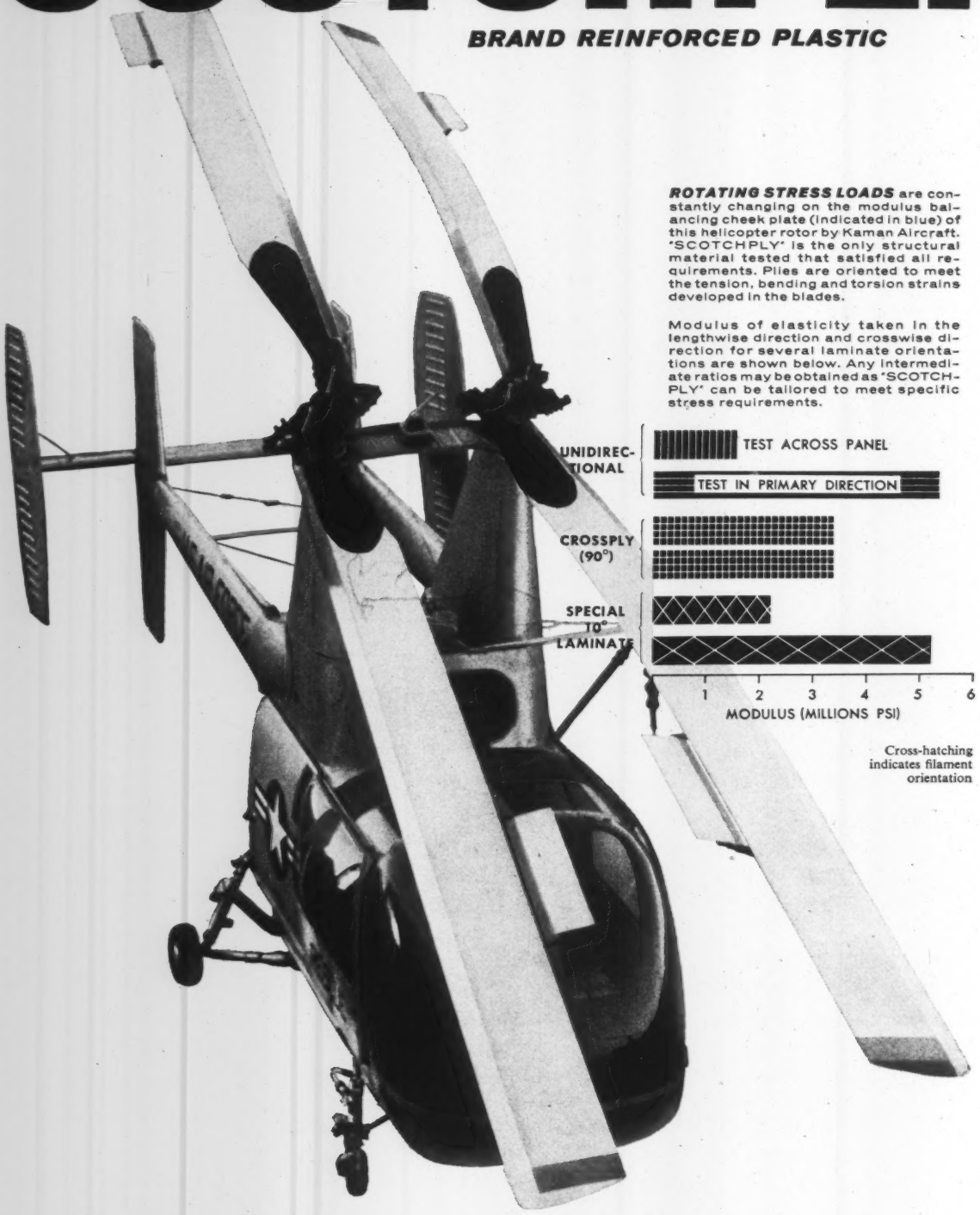
Address_____

City_____ Zone____ State_____

For more information, turn to Reader Service card, circle No. 511

SCOTCHPLY®

BRAND REINFORCED PLASTIC



ROTATING STRESS LOADS are constantly changing on the modulus balancing cheek plate (indicated in blue) of this helicopter rotor by Kaman Aircraft. "SCOTCHPLY" is the only structural material tested that satisfied all requirements. Plies are oriented to meet the tension, bending and torsion strains developed in the blades.

Modulus of elasticity taken in the lengthwise direction and crosswise direction for several laminate orientations are shown below. Any intermediate ratios may be obtained as "SCOTCHPLY" can be tailored to meet specific stress requirements.

Cross-hatching indicates filament orientation

STRENGTH-TO-WEIGHT RATIO TOPS ALL STRUCTURAL MATERIALS

Strength/weight and other exclusive properties result from customized orientation of continuous, non-woven glass filaments*

What's the big difference between "SCOTCHPLY" and other pre-impregnated reinforced plastics? Only "SCOTCHPLY" BRAND Reinforced Plastic has continuous, non-woven glass filament* reinforcement.

Here are the superior properties that result:

★ ***UNMATCHED INDIVIDUAL PLY STRENGTH***—each ply consists of *continuous straight* filaments in parallel alignment, not crimped or woven.

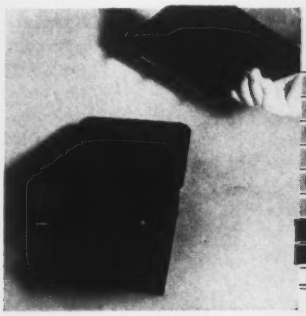
★ ***HIGHEST DEGREE OF TAILORABILITY***—individual plies may be oriented to meet specific stress requirements; reinforcement (weight and bulk) is not wasted in directions or regions of low stress. This *degree* of tailorability is not possible with other reinforced plastics using woven cloth or short strand reinforcement.

This duo of exclusive advantages combines to give "SCOTCHPLY" an unequalled strength-to-weight ratio and superior fatigue properties.

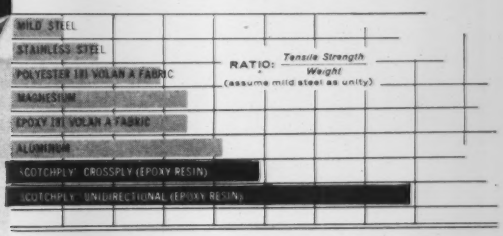
Sold in uncured rolls or sheets, "SCOTCHPLY" Reinforced Plastic is a moldable, laminated plastic consisting of a mechanically controlled ratio of resin to reinforcement*. Heat and low pressure in matched metal dies, vacuum or pressure-bag molding cure it into rigid form.

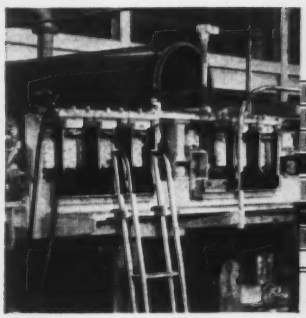
For complete information and technical service, write on your letterhead to Dept. XAB-129. Reinforced Plastics Division, 3M Co., 1210 University Ave., St. Paul 4, Minn.

**Other available filaments: nylon, asbestos and other ablation materials. Epoxy, phenolic and other resin systems are available.*

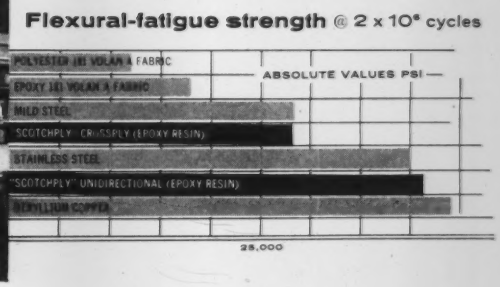


EXTREMELY HIGH TENSILE STRENGTH and light weight are essential in this battery case by Prewitt Aircraft for a classified missile. By proper orientation of reinforcing filaments, "SCOTCHPLY" provides maximum strength where strength is needed to withstand tremendous acceleration loads.





FLEXURAL FATIGUE failure of metal Fourdrinier springs resulted in costly breakdowns on this paper machine manufactured by Rice Barton Corporation. Now Fourdrinier springs of "SCOTCHPLY"—tailored to the application—do the job.



"SCOTCHPLY" IS A REGISTERED TRADEMARK OF THE 3M CO., ST. PAUL 6, MINN. EXPORT: 99 PARK AVE., NEW YORK 16, N. Y. CANADA: LONDON, ONTARIO

MINNESOTA MINING AND MANUFACTURING COMPANY

. . . WHERE RESEARCH IS THE KEY TO TOMORROW

3M COMPANY

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a complete range of brush materials for printed circuit applications.

Because the correct choice of contact materials for use on printed circuits is wholly dependent upon such factors as type of circuit, circuit function and mechanical design, the final selection of materials is generally obtained on an empirical basis.

Baker engineers and metallurgists are prepared to offer very broad, specialized experience, together with extensive records of performance data that can be extremely useful to you. They will be pleased to assist in resolving your particular problems in this field.

Baker-developed alloys and powdered metal products meet the full range of brush material requirements for printed circuit applications. Complete facilities are available here for reliable design and manufacture. Send for literature.

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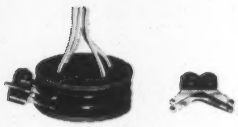
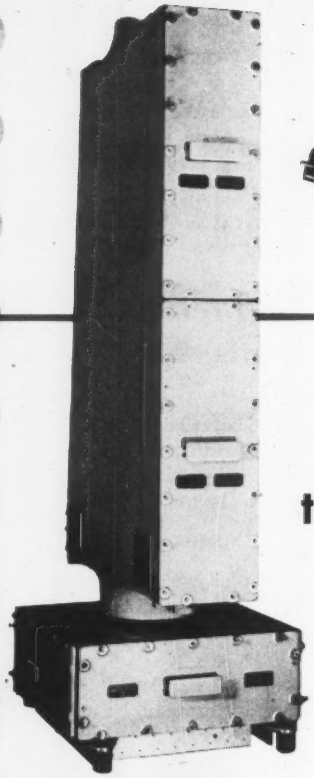
BAKER CONTACT DIVISION

recognized leadership in the design and manufacture of slip ring assemblies.





The country's leading producers of electrical and electronic equipment look to Makepeace for the design and manufacture of slip ring assemblies.

Slip ring design for particular applications depends upon the various electrical and mechanical factors involved. Thus, Makepeace has developed many special alloys and combination of alloys to meet a wide range of requirements. Our engineers and metallurgists are thoroughly qualified in this specialized field and will be pleased to make recommendations on your particular problem.

Complete facilities are available for the manufacture of slip ring assemblies ranging in diameter from 1" to 48" and larger—for General Purpose, Radio Frequency and Video Ring Circuits, High Speed Instrumentation, High Voltage Ring Circuits and Power Pulse Slip Rings. A slip ring data file is available—write for your copy.

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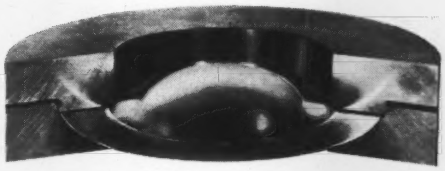
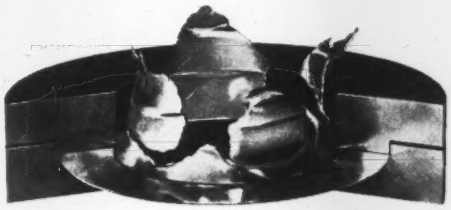
corrosion-resistant rupture discs for dependable instant and automatic relief of excess pressure





In pressurized apparatus subject to corrosive action, precious metal rupture discs provide the safest, most accurate and dependable relief. Platinum, gold, and silver are now generally recognized as specifics when dealing with corrosion. Each is resistant to the corrosive effects of an important group of liquids and gases and will remain unattacked under conditions that would render many base metal materials useless. These rupture discs, depending on material selected, are guaranteed to be burst ± 5% of specified pressure. Intrinsic value adds to the original cost of these discs but the actual metal value is recovered, no matter how torn or battered the discs may be. Send for Bulletin.

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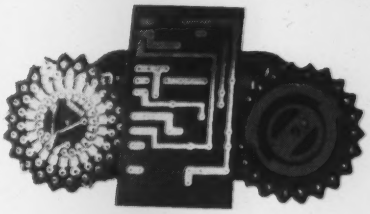
gold and rhodium plating for corrosion-resistant surfaces



ATOMEX® is a 24k gold immersion solution that permits the deposition of a thin, dense, uniform layer of 24k gold on printed circuits and metallized plastics by means of a simple bath. The Atomex procedure is more permanent and less expensive than electroplating of comparable thickness. Costly analytical control is unnecessary.

Rhodium—a complete line of plating solutions are also available for high-reliability electrical and electronic applications. Rhodium is highly resistant to corrosive atmospheres, oxidation and arc erosion—reduces wear on moving surfaces—assures low noise level for moving contacts, no oxide rectification, low and stable contact resistance. Rhodium plating is indicated when a low-resistance, long-wearing, oxide-free contact is required. Send for literature.

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Columbium

makes possible

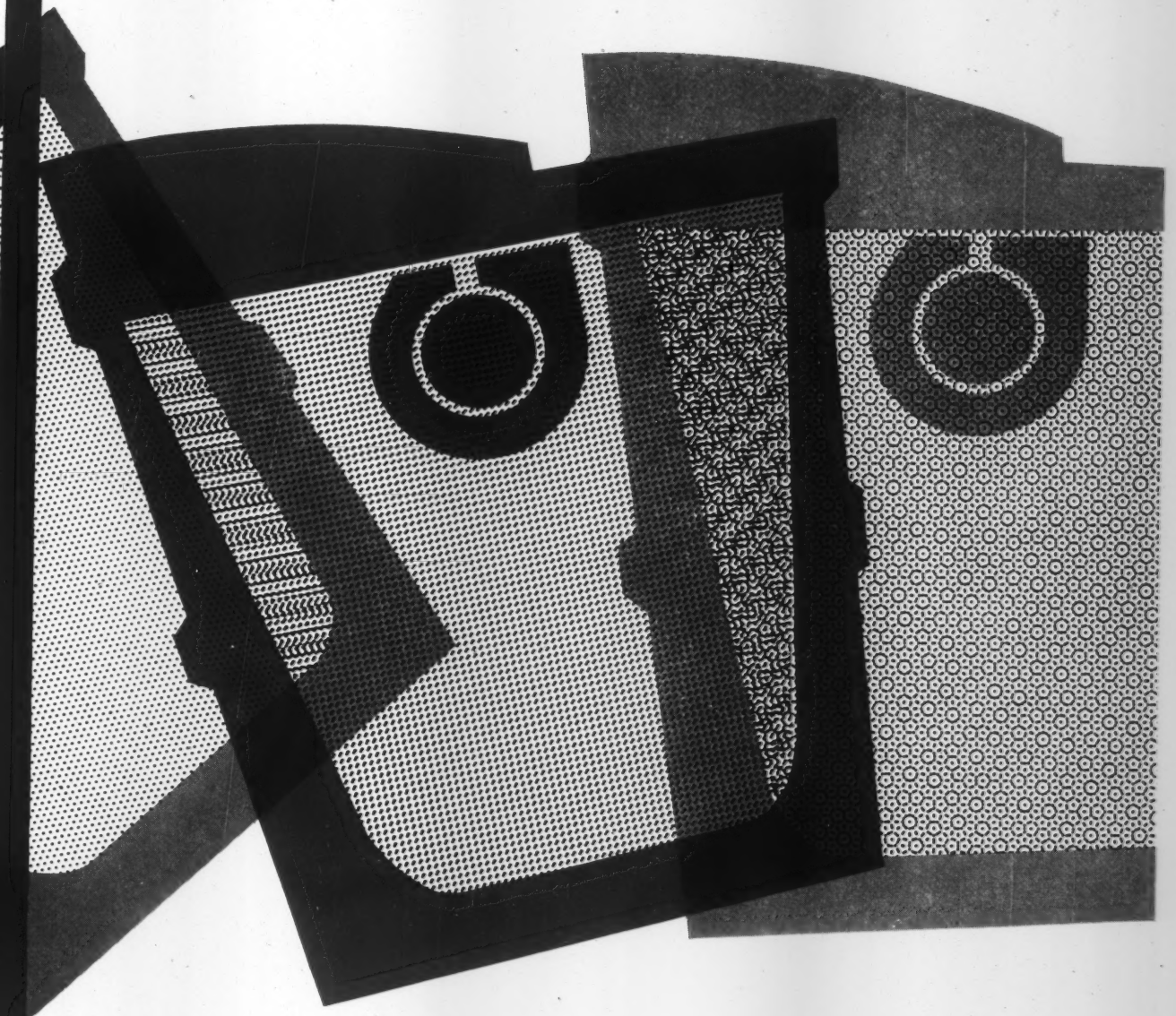
this unique

new

fine-grained

carbon steel

GLX-W



Compare fine-grained GLX-W with the steel you use

Great Lakes adds a precise amount of columbium to good-quality carbon steel. The result is fine-grained GLX-W steel. Here's how GLX-W compares with mild carbon steels . . .

- GLX-W is 50-100% stronger
- Has greater notch toughness
- Has excellent weldability
- Is as ductile as other carbon steels
- Permits designers to reduce weight up to 35%.

For proof on how GLX-W can cut your production costs, write, wire or phone Great Lakes Steel Corporation, Product Development Division, Department D-12.

GLX W **GREAT LAKES STEEL**
Detroit 29, Michigan
A DIVISION OF NATIONAL STEEL CORPORATION

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Sliding contacts for printed circuits are plated with rhodium, over nickel, to obtain tarnish-free, hard surfaces for long and economical service life. (The illustration is rose-tinted . . . rhodium derived its name from its salts of this hue.)

CONTACT SURFACES OF PRINTED CIRCUIT SWITCHES...

Where any metal but Rhodium would cost too much...

Not so long ago, switch contact surfaces of printed circuits going into computers, guidance devices and advanced instrumentation wore out much too soon.

To Litton Industries, U.S. Engineering Co. Division, the problem was important and they soon came up with the answer. Investigation proved non-tarnishing rhodium, plated on nickel, was the metal for the job.

And it paid off! What started as an engineers' dilemma ended as an important contribution by Litton to printed circuit designing.

Rhodium proved easy and dependable to electroplate and the contact surfaces had the desired wear resistance. The rhodium-finished switch contact surfaces now give long life and reliable service. What's more, rhodium provides this superior performance for less than five cents per board.

A platinum metal may economically solve your problems

Where a hard surface, immune to tarnish, is required, as in electrical contacts... where conditions involve high temperature and product purity, as in the production of lens glasses... where peak catalytic efficiency is needed, as in the refining of high octane gasoline... or where a combination of severe corrosion or erosion must be met, as in the case of spinnerettes for rayon production . . . the platinum metals often prove to be the most economical materials for critical equipment.

Industry is going to higher temperatures and higher pressures. Perhaps your own progress has been blocked by the limitations of materials to withstand such severe conditions. The platinum metals have removed many barriers. Have you considered them for your problems?

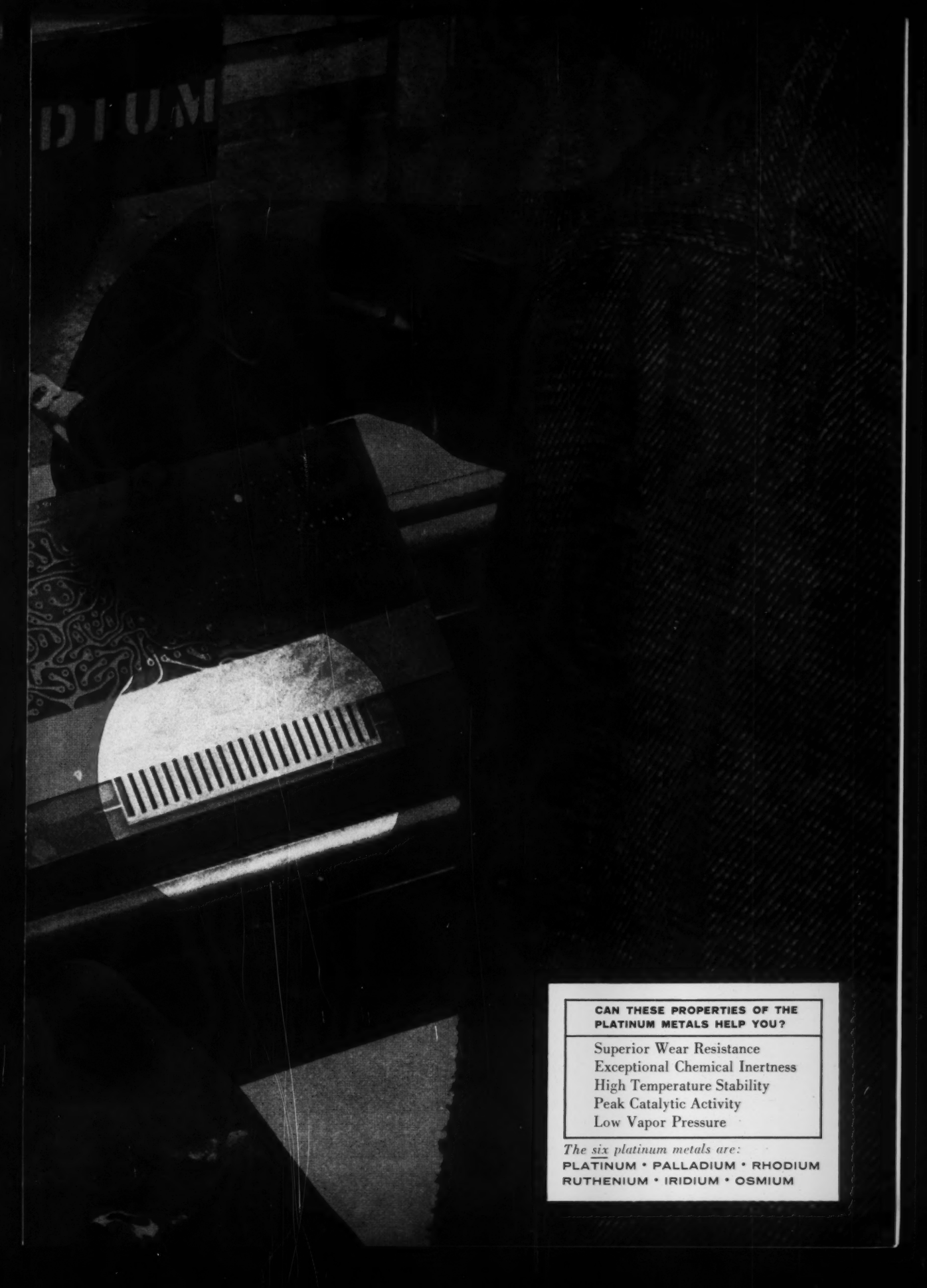
Platinum, palladium, rhodium, ruthenium and iridium have unique potentials, well worth your attention. Specialists are prepared to work closely with you in evaluating these metals for new commercial and scientific uses.

As a first step, write us for additional data on the outstanding characteristics and successful applications of the six platinum metals and their alloys — indicating your field of interest or how we might be of assistance.

INCO PLATINUM METALS DIVISION

The International Nickel Company, Inc., 67 Wall Street, New York 5, N.Y.

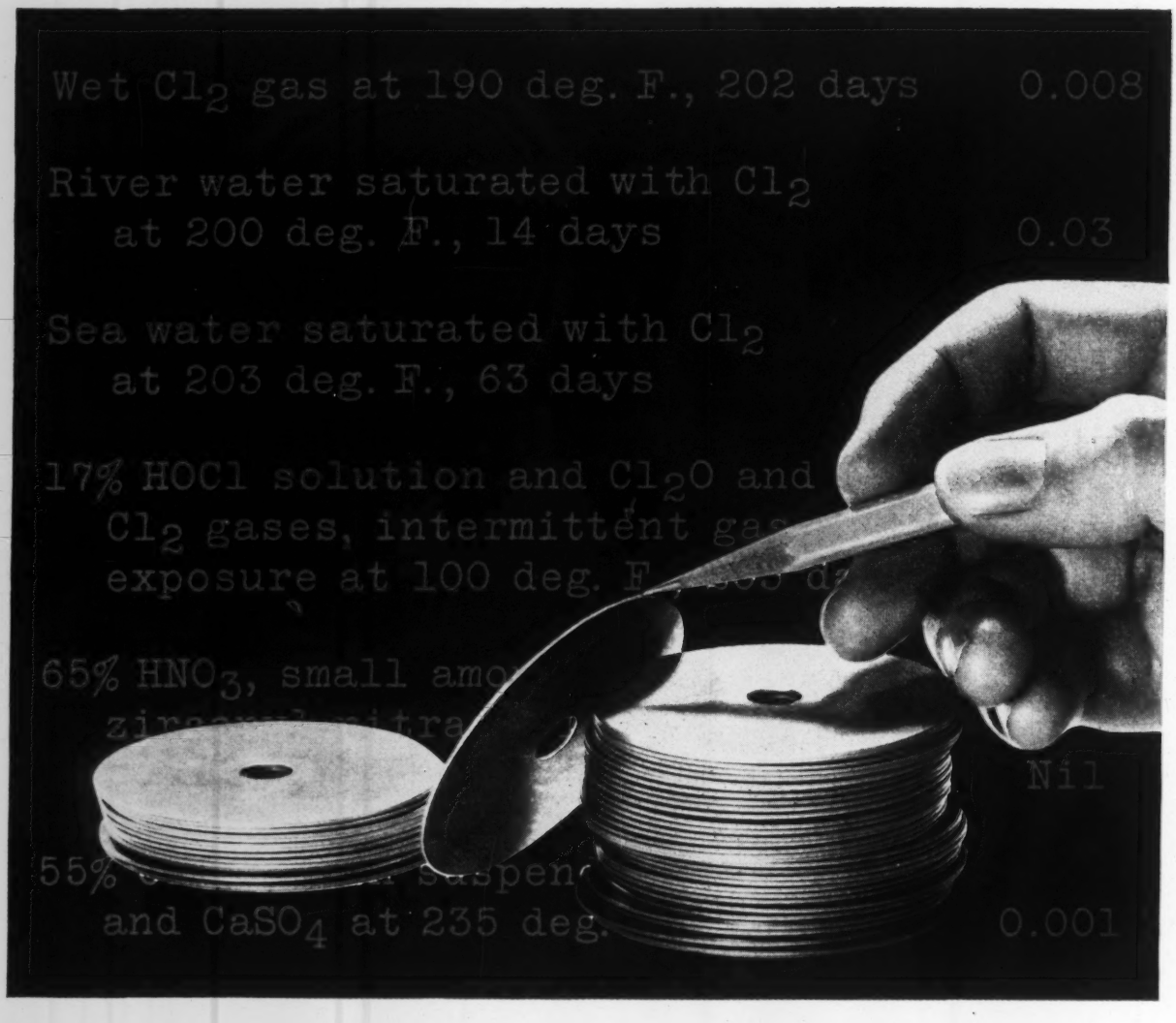
For more information, circle No. 373



CAN THESE PROPERTIES OF THE PLATINUM METALS HELP YOU?

Superior Wear Resistance
Exceptional Chemical Inertness
High Temperature Stability
Peak Catalytic Activity
Low Vapor Pressure

The six platinum metals are:
PLATINUM • PALLADIUM • RHODIUM
RUTHENIUM • IRIDIUM • OSMIUM



One of the most comprehensive tests undertaken confirms titanium's outstanding corrosion resistance

Encouraged by increasing availability (and lowering costs) of titanium, more and more designers of process industry equipment are testing and applying its unique corrosion resistance and other properties.

One of the most extensive evaluations ever made, with actual chemical plant exposures, was a seven-plant series of tests by Columbia-Southern Chemical Corporation. The tests, covering 2300 specimens of 40 materials involved many environments.

Test results led Columbia-Southern to broaden use of titanium in actual equipment such as valves, heating coils, nitric acid reboilers... in their most corrosive media. In service for nearly a year, the equipment has confirmed the earlier findings.

The detailed results of this test are well worth your study. Write for your copy of a summary report today.

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Division of Union Carbide Corporation,
30 East 42nd Street, New York 17, N.Y.
In Canada—
Union Carbide Canada Limited, Toronto

UNION CARBIDE METALS

Electromet *Brand Ferroalloys and other Metallurgical Products*

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There's a valuable premium in every shipment of Foster Grant resin...

40 YEARS of successful plastics experience

This experience dates back to 1919, when Foster Grant first entered the plastics business as a customer of raw materials and as a manufacturer of end products.

Through the years, Foster Grant has seen the world of plastics from the "molder's eye" view. And today, as a leading producer of plastic materials, Foster Grant retains the special ability to understand the molder's problems.

When you specify Foster Grant Resins, you draw on the resources of this valuable, practical plastics experience.

Your Partner in Plastics Progress **FOSTER GRANT**
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Plants: Leominster, Mass. • Baton Rouge, La. Manchester, N. H.

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Manufacturers of Fostarene® Polystyrene • Fosta® Nylon • Fosta Tuf-Flex® Impact Polystyrene

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For SIMMONS "room of tomorrow" it's Du Pont's "finish"

- Introduction of new kind of finish adds sales impact to Simmons line
- Change-over from conventional topcoat to "Lucite" Enamel accomplished without changes in finishing-line equipment
- Improved product appeal typifies benefits of working with Du Pont

In developing the new "room of tomorrow" furniture line for modern hotels and motels, the Simmons Co. placed particular emphasis on the finish. It had to have sales appeal as dynamic as the design of the room itself . . . yet production costs had to be low.

The answer was Du Pont "Lucite" Acrylic Enamel—a new lustrous finish formulated in a wide variety of decorator colors. Du Pont specialists helped Simmons convert from conventional enamel to "Lucite" *without changes in costly finishing equipment.*

Like Simmons, most manufacturers can benefit when experienced Du Pont personnel work with them to assure efficient use of industrial finishes. Here is experience in *depth* . . . not only from technically trained Du Pont salesmen and service men, but also from the laboratories of the world's foremost paint-research organization.

Du Pont specialists have the "know-how" needed to apply finishes by any method, in practically any industry. They'll recommend a finishing system that can solve your problem . . . work with your staff on a continuing basis. Best of all, *they can help you develop better finishing at lower costs.*

If finishing is part of your production, it will pay you to see a Du Pont representative. Write: E. I. du Pont de Nemours & Co. (Inc.), 2502 Nemours Bldg., Wilmington 98, Delaware.

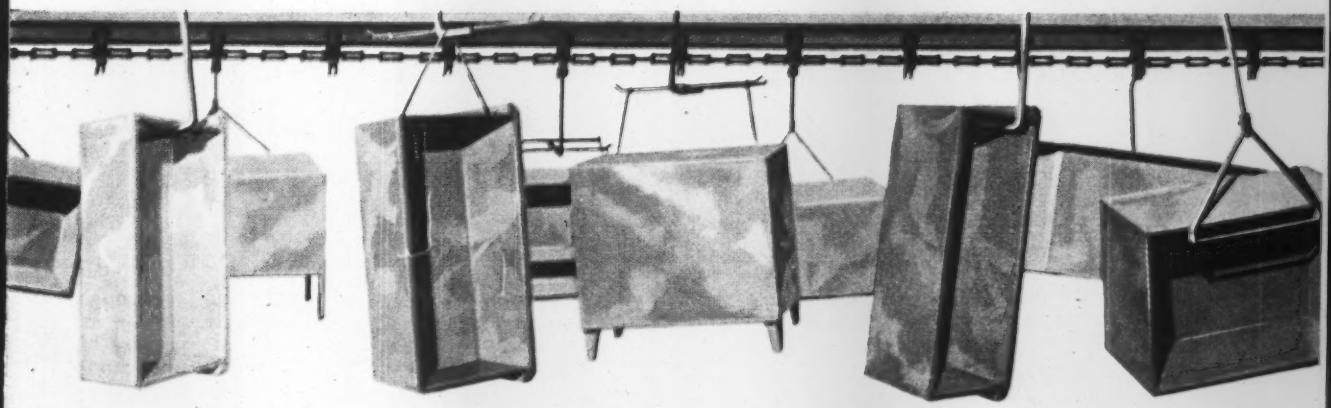
PRESSURE POTS containing "Lucite" Enamel are checked. Each hue sparkles in a diamond-clear "Lucite" base, a powerful sales look for this Simmons line!

Du Pont Finishes Service Package—**FORMULATION, APPLICATION,**

SPRAY OPERATION assures a uniform coating of "Lucite" Acrylic Enamel on the furniture passing through on the conveyor line. Du Pont specialists worked closely with Simmons personnel to convert this spray line to "Lucite" without changing finishing equipment. Result: minimum downtime, no changeover costs. Regular calls by Du Pont service men assure a continuing high level of efficiency.

REGULAR MEETINGS between Simmons and Du Pont personnel keep customer informed about the latest finishing developments and production techniques . . . help keep costs low. Here, talking over a point in finishing, are W. C. Van Clief, Jr., manager of engineering, L. H. Weyrough, division general manager, H. A. Morman, finishing supt., R. C. Costello, manager of purchasing, G. H. Simpson, Du Pont salesman.

furniture–
tomorrow" LUCITE® Acrylic Enamel



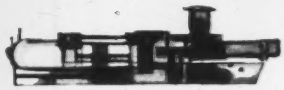
READY FOR DELIVERY. Complete furniture with baked-on "Lucite" Enamel emerges from drying ovens en route to shipping room. Next stop: one of the striking "room of tomorrow" interiors. "Lucite" stays bright and beautiful longer than conventional finishes . . . resists printing, scratching, chipping, cracking and burning exceptionally well. Water rolls off . . . dirt slides off the jewel-smooth finish, assuring easy maintenance.

FOLLOW-THROUGH—*Sets Today's Production Pace*

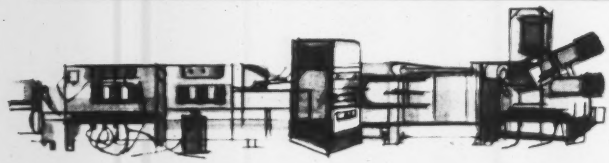
DU PONT
REG. U.S. PAT. OFF.

For more information, circle No. 492

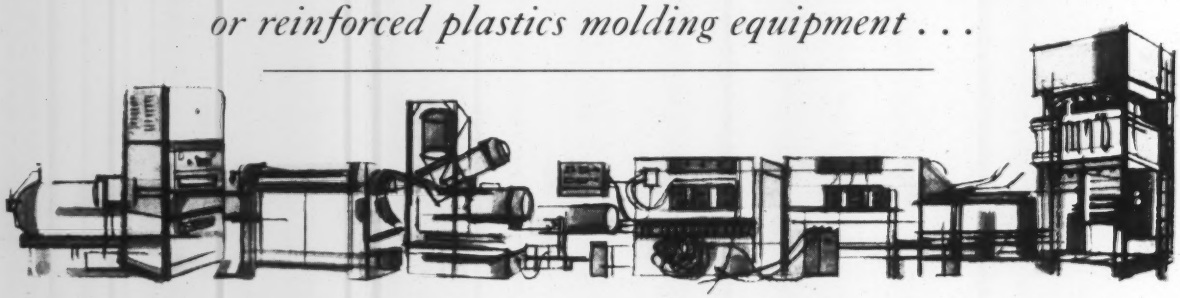
BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*



Hundreds of plastic molders have presses for one or two types of molding . . .



some have vacuum forming, extrusion, compression, injection or reinforced plastics molding equipment . . .



But only one has more equipment . . . in more types . . . and more sizes . . . than anyone else in the world!

GENERAL AMERICAN

Plastics Division

General American's Plastics Division offers you advantages that no other molder in the world can match!

- The largest and most varied molding facilities in the industry, with compression presses up to 2000 tons for regular and reinforced plastics in simple and complex shapes, injection presses up to 300 ounces, and large extruding and vacuum-forming machines.
- An experienced staff of research and development specialists, and a complete engineering department.
- Modern tool and die shops.
- A continuing advisory service, including a Customer Service Manager assigned to live with your job through every step of production.

These are some of the reasons why General American is the nation's leading custom molder of plastics. Let us study your products to help you determine whether the use of custom molded plastics will improve them. You'll find . . . *it pays to plan with General American.*

GENERAL AMERICAN TRANSPORTATION CORPORATION

135 South LaSalle Street, Chicago 4, Illinois
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Plastics Division

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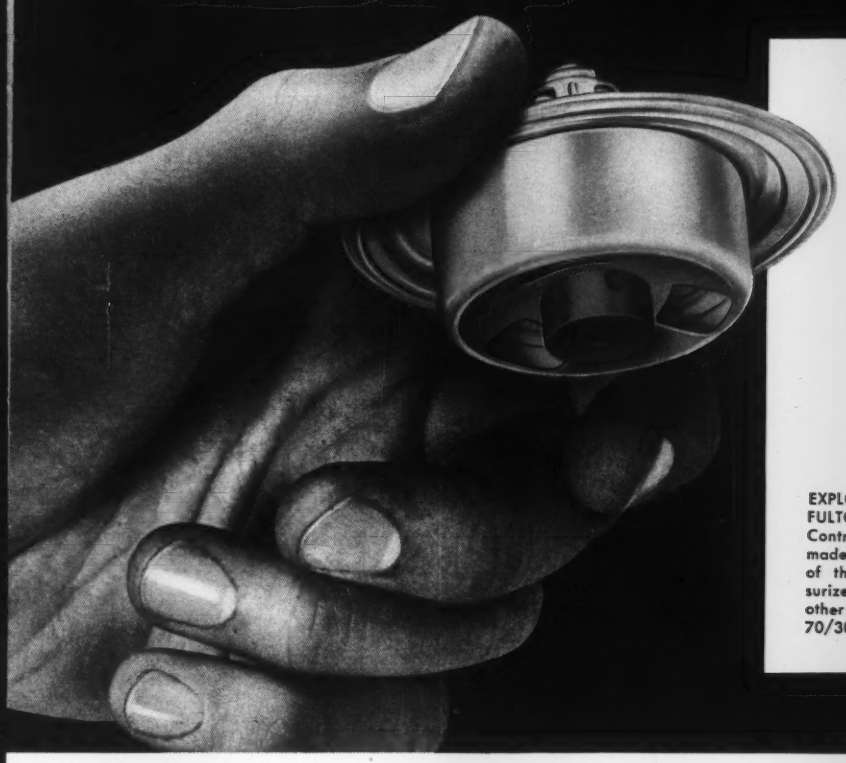
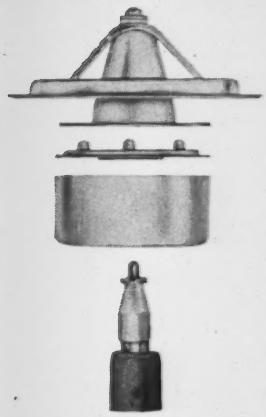
AGAIN-





EXPLODED VIEW OF AUTOSTAT® made by FULTON SYLPHON DIV., Robertshaw-Fulton Controls Co., shows impact extruded cup made from Revere Copper Rod. Other parts of this superior thermostat used in pressurized cooling systems in automobiles and other automotive equipment, are made of 70/30 Revere Brass Strip.

Revere helps "fit the metal to the job"

AND A LEADING MANUFACTURER OF AUTOMOTIVE THERMOSTATS IS ABLE TO PRODUCE A SUPERIOR PRODUCT FOR LESS MONEY

That little unimportant-looking copper cup shown above originally posed a king-sized production problem. It is a critical part of a newly designed automotive thermostat made by the Fulton Sylphon Division of the Robertshaw-Fulton Controls Co., Knoxville, Tenn.

In the early stages this copper cup was machined from free cutting copper rod, but this proved costly due to the high rate of scrap from the machining operation and the relatively high cost of turning out the machined part. At this point Revere Technical Advisors got together with Fulton Sylphon Engineers and the possibility of an impact extrusion was discussed. Revere T.A.'s in turn contacted suppliers who might furnish these extrusions in copper, to see whether or not they could be produced economically and to the demanding specifications required.

After exhaustive tests it was found that the cup could be impact extruded to meet the exacting hardness specifications of Fulton Sylphon. During its development, many problems involving temper, grain size and control of the chemical composition of the copper rod had to be solved.

In addition to the Copper Cup, Revere also supplies 70/30 Brass Strip from which other parts of the AUTOSTAT® are fabricated.

Said a Fulton Sylphon purchasing agent, "When you ask Revere for help you really get results."

This is still another case of how Revere, a supplier, working with still another supplier, was able to help its customer produce a superior product for less money. Why don't you take advantage of this service?

REVERE COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue

New York 17, N. Y.

Mills: Rome, N. Y.; Baltimore, Md.; Chicago and Clinton, Ill.; Detroit, Mich.; Los Angeles, Riverside and Santa Ana, Calif.; New Bedford, Mass.; Brooklyn, N. Y.; Newport, Ark.; Ft. Calhoun, Neb. Sales Offices in Principal Cities, Distributors Everywhere.

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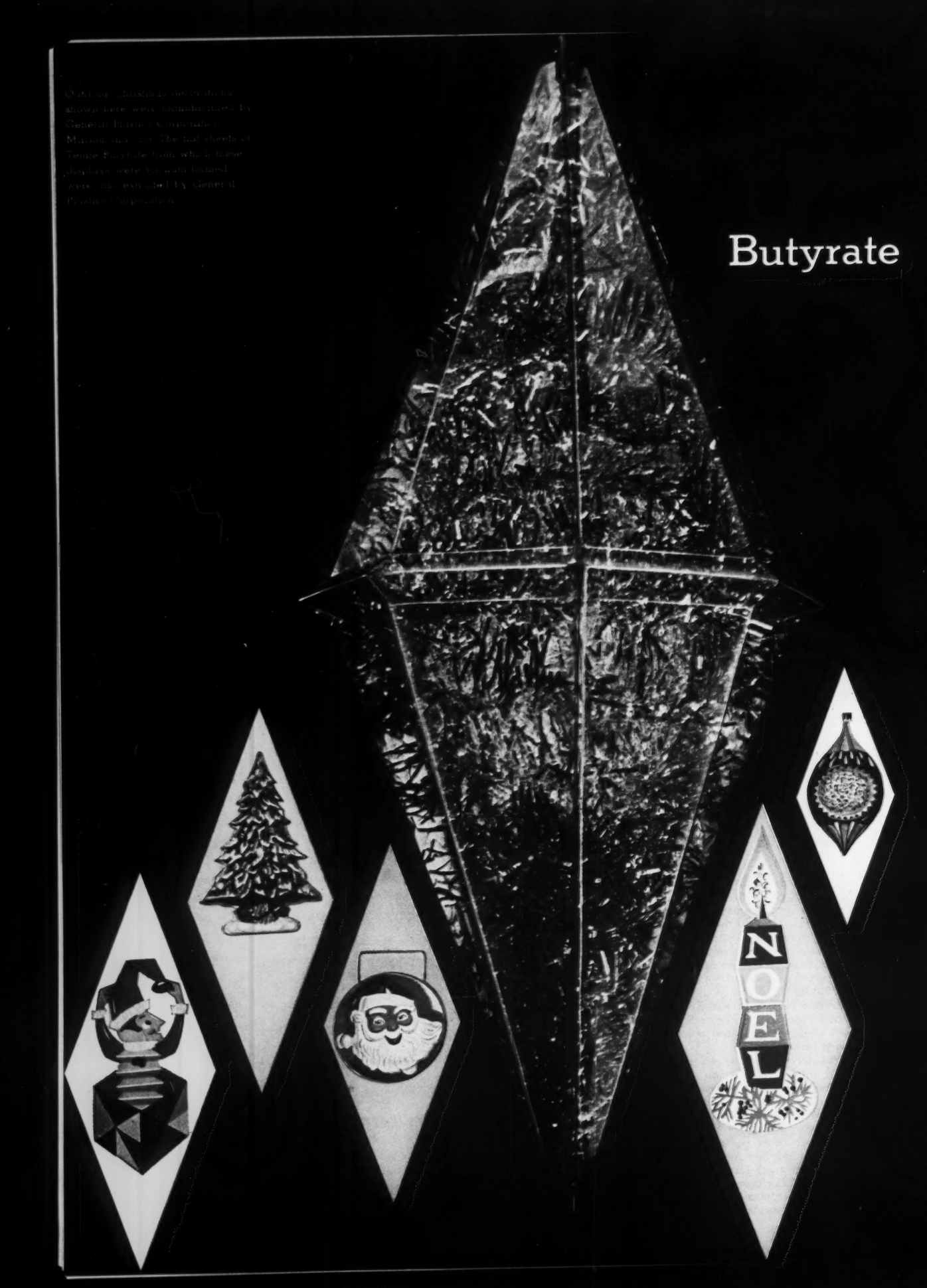
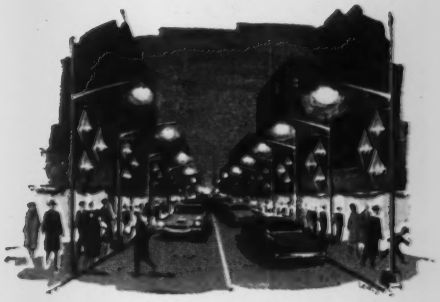
Outdoor Christmas decorations shown here were fabricated by General Plastics Corporation, Manitou, Wisconsin. The flat sheets of Tenite Butyrate from which these displays were vacuum formed were also fabricated by General Plastics Corporation.

Butyrate



gives the gift of long life to giant outdoor Christmas decorations



Street displays made of tough, weather-durable Tenite Butyrate plastic help communities spread Christmas cheer for many years

When you need a plastic with long outdoor life, you find a ready answer in Tenite Butyrate.

Its durability has been proved by displays like these and by hundreds of other applications in many different fields, including such products as automobile taillight lenses, marine buoys, outdoor signs and oil-field pipe.

Yet, the outstanding weatherability of Tenite Butyrate seldom is the sole reason for its use. Rather, it is Butyrate's *combination* of properties that usually dictates its choice for a specific job.

The Christmas decorations shown here are an ideal illustration of how Butyrate's properties can be mated to the demands of a specific use.

Outdoor durability certainly is an important consideration for these decorations. Exposed to weather extremes ranging from sub-zero Alaska to sunny Florida, they must be able to endure in any location, showing excellent resistance to cracking, crazing or "aging."

They must also be tough enough to take the abuse of repeated installation and dismantling, plus the hazards of storing and transporting.

Butyrate satisfies these requirements... and other specifications of the manufacturer, such as availability in a crystal-like, clear-transparent formulation, resistance to yellowing by sunlight, and a high surface luster.

Fabricating advantages, too, complement the service excellence of Butyrate. Because of the ease with which extruded sheet of Butyrate can be vacuum-formed over inexpensive molds on fast-cycle machines, production costs are kept at a minimum. Even decorating costs are low; for the multicolored patterns are applied by silk-screening the inside face of the display before forming, thus protecting the printing from the weather and preserving a naturally glossy exterior. Subsequent fabricating operations such as trimming, punching, stapling, riveting or grommeting are easy to carry out without danger of crazing or cracking.

If you'd like to consider Tenite Butyrate for one of your material needs, let us hear from you. We'll be glad to discuss your application in confidence, and help you evaluate the suitability of Butyrate. For this assistance or for more information, write EASTMAN CHEMICAL PRODUCTS, INC., subsidiary of Eastman Kodak Company, KINGSPORT, TENNESSEE.

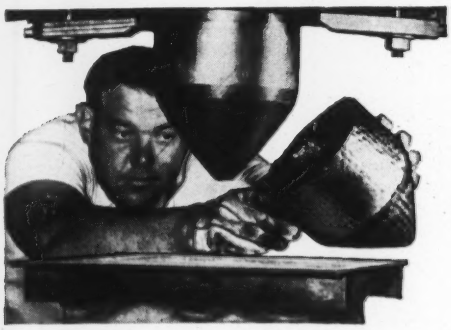
TENITE®

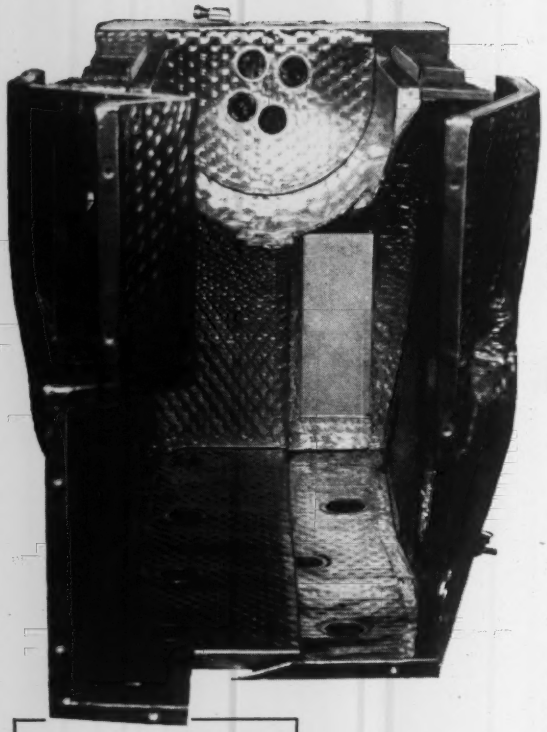
BUTYRATE

an Eastman plastic

For more information, circle No. 411

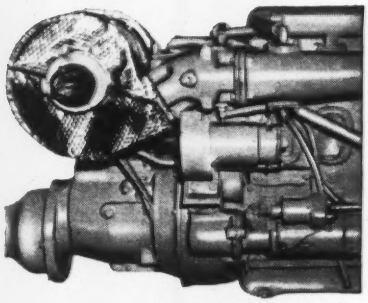
Johns-Manville PRE-KLAD insulations are made possible through the company's extensive experience in fabrication and forming of thin foils.





This typical PRE-KLAD insulated housing features combination of molded parts, strengthened channel construction, close tolerance cut-outs to accommodate fittings and attachments.

Now—insulate difficult shapes in one fast operation . . .



PRE-KLAD as used by diesel engine manufacturers. Here, J-M engineers worked with customer's engineers to develop insulated blankets that readily slip over turbochargers to protect personnel and keep engine room temperature down.

Among the many PRE-KLAD applications

- Gasoline Engines
- Gas Turbine Engines
- Steam Turbines
- Heated Mechanical Equipment
- Domestic and Industrial Furnaces
- Stress Relieving Blankets
- Ingot Pads
- Heated Laboratory Equipment
- Diesel Engines, Manifolds, Turbochargers
- Home Incinerators, and other Hot Appliances
- Portable Heat Retention Equipment
- Turbogenerators
- Materials Handling Equipment
- Gear Housings
- Removable Casting and Forging Covers
- Furnace Nozzle Cones

with Johns-Manville PRE-KLAD Insulation!

New refractory fiber insulation is factory sheathed in heat-resistant foils to any required shape . . . temperatures to 2000F!

In new PRE-KLAD insulation, designers have an insulation that's right in step with efficient assembly line methods. For PRE-KLAD components arrive at your plant ready to install . . . in one fast operation!

Originally developed for jet aircraft . . . PRE-KLAD insulations are precision engineered to solve individual heat retention problems. Johns-Manville tool engineers create the special molds and dies to form the stainless steel or other thin foils into the shape you require. Then, refractory felt insulation is expertly sandwiched between inner and outer foil jackets, which are then spot- or seam-welded into a ready-to-install housing or blanket. The result is an insulating component that can be used wherever a strong, lightweight foil-protected insulation is indicated.

The insulation in PRE-KLAD is Johns-Manville CERAFELT® . . . a refractory fiber insulation that is produced by converting molten refractory materials into a mass of uniform ceramic fibers. The fine CERAFELT fibers are then felted with a minimum of binder to form an insulating material that combines lightness, heat resistance and an extremely low *k* factor.

Write today for the informative new brochure on PRE-KLAD insulations.
Address Johns-Manville, Box 14, New York 16, N. Y. In Canada, Port Credit, Ont.

JOHNS-MANVILLE

JOHNS-MANVILLE JM PRODUCTS

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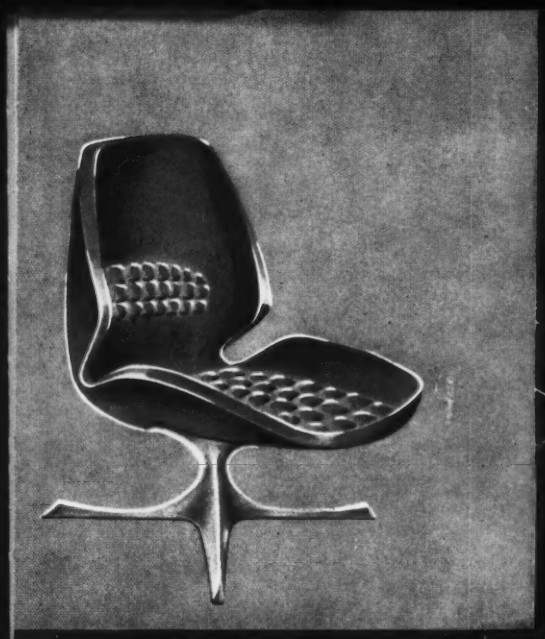
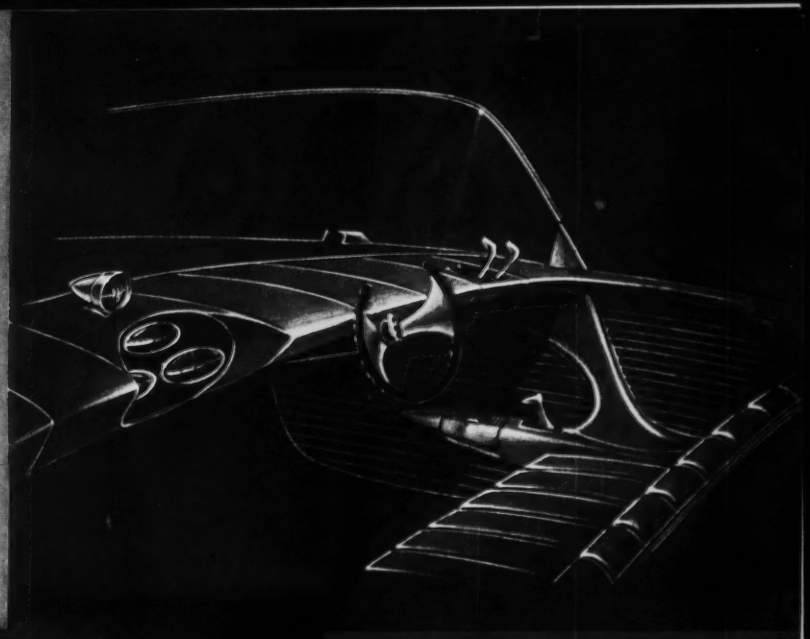
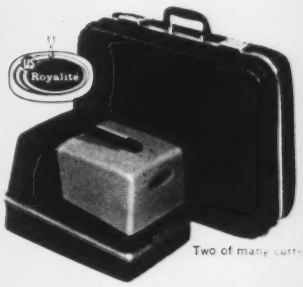




Shape your product future with U.S. Royalite®

ABS THERMOPLASTIC SHEETS

Here is a versatile thermoplastic sheet material that forms to *any* shape in sharp detail – and still answers the basic design problems of toughness, beauty and economy. Used as a tool for advanced thinking, U.S. Royalite makes new, modern product designs practical. Check these advantages: (1) Royalite is extra tough to resist hard knocks and scrapes, is impervious to grease and oil, nonrusting and unaffected by most chemicals. (2) Royalite molds cleanly, without seams or sharp edges to snag or chip. (3) Royalite gives you new textured beauty in a wide range of colors built in to last. (4) Royalite is extra light, making portable products even more portable. (5) Royalite is economical to use. Advanced fabricating techniques permit its wide use on popular-priced items. Send for free, file-size specifications booklet.



Two of many current applications of U.S. Royalite

ROYALITE PLASTIC PRODUCTS

United States Rubber

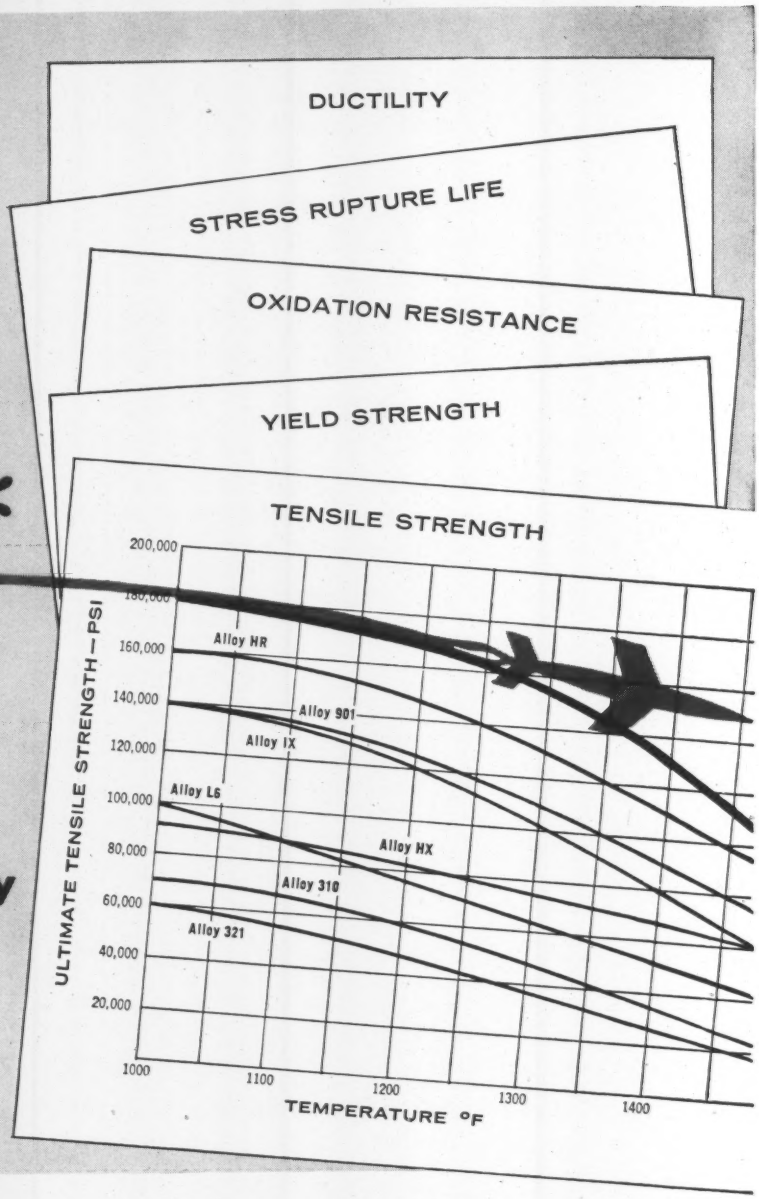
2638 North Pulaski Rd., Chicago 39, Illinois

HIGH

on every chart:

RENÉ 41*

most dependable alloy in use today in the 1200°- 1800°F range



In *all* ways, René 41 is a remarkable alloy. No other high-temperature alloy used in production today equals its tensile strength. In other properties, too, René 41 is far ahead of the field.

Also important, this nickel-base, vacuum-melted alloy is easy to work with. It's readily formable by drawing, bending, spinning — welds to similar or dissimilar materials.

Cannon-Muskegon offers René 41 in standard 36″x 96″ sheets .015″ to .125″ thick, in smaller sizes down to .010″, in bar stock up to 3″ in diameter... foil down to .001 in thickness... and fine wire only .0015 in diameter.

For complete details, write for Technical bulletin No. 86.

*TM of General Electric Co.

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VACUUM ALLOYS

CANNON-MUSKEGON CORPORATION

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Aluminum Forgings. Aluminum Co. of America, 38 pp, illus. Properties, uses and heat treatment of aluminum forgings. Shows facilities for producing aluminum forgings. 1

PVC Protective Lining. Amercoat Corp., 6 pp, illus. Describes a dense, flexible PVC (polyvinyl chloride) sheet for lining plating, pickling and other tanks and vessels. 2

Galvanized Steel Sheet. American Zinc Institute, Inc., 36 pp, illus. Describes the significant factors governing properties, applications, specifications, purchase and maintenance of galvanized steel sheet for industrial uses. 3

Extruded Manganese Bronze. Ampco Metal, Inc., No. G53. Chemical composition, properties, uses and advantages of a wear resistant, extruded manganese-bronze alloy for high production jobs. 4

Spray System for Reinforced Plastics. Archer-Daniels-Midland Co., 12 pp, illus. Describes a spray gun that sprays a variety of plastics materials in conjunction with fibrous and aggregate materials for making reinforced plastics parts, and for applying protective coatings. 43

Epoxy Fluidized Coatings. Armstrong Products Co., 3 pp, illus. Information on epoxy resin powders for fluidized bed coating. Specifications and features of fluidized bed equipment. 5

Polyester Resin. Atlas Powder Co., Chemicals Div., 11 pp. Properties, uses and room temperature curing system for a new polyester resin called Atlac 382. 6

Polypropylene Film. AviSun Corp. Physical and mechanical properties, heat and corrosion of polypropylene film. 7

ABS Plastics Resins. Marbon Chemical Div., Borg-Warner Corp., 8 pp, illus. Mechanical, electrical and thermal properties of ABS (acrylonitrile-butadiene-styrene) plastics. Describes the use of ABS plastics resins for molded parts, extrusions and formable sheet. 8

Nonferrous Solid, Cored Forgings. Bridgeport Brass Co., 12 pp, illus. Discusses the differences in cost and processing between castings, complicated machined part assemblies, and solid and cored nonferrous forgings. 9

Alloy Steel Castings. Calumet Steel Castings Corp., 4 pp, illus. Information on two alloy steels for use in castings. Information also on such cast steel parts as rolls, eyebolts, nozzles, hooks and aspirators. 44

Silicon Carbide Foam. Carborundum Co., Research & Development Div., 3 pp, illus. Mechanical shock resistance, fabricating data and uses of silicon carbide foam. 10

Specialty Steels. Carpenter Steel Co., 40 pp, illus. Properties and uses of tool and die steels, stainless steels, high temperature alloys, electronic, magnetic and electrical alloys, special purpose alloy steels, tubing and pipe, and fine wire specialties. 11

Vacuum Formed Plastics. Chanal Plastics Corp., 8 pp, illus. Facilities for producing vacuum-formed thermoplastic industrial parts, displays, toys, lighting panels and packaging. 12

Bright Dip for Stainless. Diversey Corp., Metal Industries Dept., 8 pp. Describes a bright dip process for polishing and descaling type 300 stainless steels. 13

TFE-Coated Fabrics. E. I. du Pont de Nemours & Co., Inc., Fabrics Div., 4 pp. Mechanical, chemical and thermal properties, formability and uses of TFE-fluorocarbon resin-coated glass fabrics and laminates. 14

Dacron-Reinforced V-Belts. E. I. du Pont de Nemours & Co., Inc., Textile Fibers Dept., 6 pp, illus. Advantages of using Dacron polyester fiber as a reinforcement in rubber V-belts. 15

Dielectric Materials. Emerson & Cuming, Inc., 10 pp, illus. Condensed listing of such dielectric materials as casting resins, foam, absorbers, adhesives, impregnants, coatings, ceramics and reflectors. 16

Epoxy Laminating Resin. Furane Plastics Inc., 4 pp, illus. Properties and uses of a room temperature curing epoxy laminating resin. 17

RTV Silicone Coating for Motors. General Electric Co., Silicone Products Dept., 3 pp, No. AD 13-C. Discusses the use of RTV (room temperature vulcanizing) silicone rubber as a protective coating for motors. 18

Cast Steel Products. General Steel Castings Corp., 54 pp, illus. Research and production facilities for making large and intricate products of cast steel. 19

Hard Chromium Electroplate. Michrom, Inc., Div. of Gits Bros. Mfg. Co., 12 pp, illus. Impact, corrosion and abrasion resistance, lubricity and uses of a hard chromium electroplate called Michrom. 20

Polyurethane Material. B. F. Goodrich Chemical Co., Div. of B. F. Goodrich Co., 16 pp. Properties and uses of a polyurethane material called Estane. Tells how to compound and process the material. 21

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Polyethylene Wire Covering. U. S. Industrial Chemicals Co., Div. of National Distillers & Chemical Corp., 4 pp. Compares polyethylene, neoprene and asphalt for their various properties in line wire covering applications. Gives advantages of polyethylene wire coverings. 28

Plastics Extrusions. National Vulcanized Fibre Co., 4 pp, illus. Facilities for making extruded shapes and fabricated parts from nylon, acetal and chlorinated polyether resins. Advantages, uses and limitations of the three plastics materials. 29

Rigid Polyethylene Plastics. Phillips Chemical Co., Plastic Sales Div., 26 pp, illus. Properties, uses and fabricating data for rigid polyethylene resins. 30

Rubber, Plastics Products. Radiator Specialty Co., Rubber Div., 16 pp, illus., No. 7000. Sizes and shapes of molded and extruded rubber parts. Information also on PVC linings, coatings, forms and shapes. 31

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Chromium-Nickel-Manganese Alloy. Rolled Alloys, Inc., 2 pp. Chemical composition, room and elevated temperature mechanical properties, creep strength, specifications and stress rupture properties for a chromium-nickel-manganese alloy supplied as sheet and plate. 33

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Soldered, Brazed Steel Tubing. Standard Tube Co., 4 pp, illus. Discusses the use of soldered or silver brazed steel tubing as a replacement for screwed or welded piping. 35

Carbon, Alloy Steel Castings. Strong Steel Foundry Co. Chemical composition and properties for various alloys that are most commonly used for steel castings. 36

Ferrous, Nonferrous Shaped Tubing. Superior Tube Co., 4 pp, illus., No. 17. Information on shaped tubing made of stainless steel, carbon and alloy steel, nickel and nickel alloys, glass sealing alloys, titanium and beryllium copper. 37

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Silicone Fluids. Silicones Div., Union Carbide Corp., 30 E. 42nd St., New York 17. Mechanical properties of silicone fluids. Write on company letterhead directly to Silicones Div.

Nitrile Thermoplastic Sheet. Royalite Plastic Products Div., U. S. Rubber Co., 4 pp, illus.

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Welding 'T-1' Steel. U. S. Steel Corp., Room 2801, 525 William Penn Place, Pittsburgh 30, 24 pp, illus. Tells how to weld 'T-1' steel. Includes a "heat input calculator" for use in welding the steel. Write on company letterhead directly to U. S. Steel.

Small Investment Castings. Vascoloy-Ramet Corp., 8 pp, illus., No. VR-470. Case histories show the advantages of using investment casting for making small parts from ferrous and nonferrous metals. **105**

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Welding Wire. Air Reduction Sales Co., Inc., 80 pp, illus., No. 2330. Properties, uses and operating data for stainless steel, aluminum, steel, copper and titanium welding wires. **47**

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Steel Forgings. AmForge Div., American Brake Shoe Co., 16 pp, illus. Properties of steel forgings. Shows forged gears, rings and pinions. **50**

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Malleable Iron Castings. American Malleable Castings Co., 4 pp, illus. Production and uses of pearlitic malleable iron castings; also specifications on both pearlitic and standard malleable iron. **52**

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Investment Castings. Arwood Precision Casting Corp., 56 Washington St., Brooklyn 1, N.Y. Nine different applications of the investment casting process. Write on company letterhead directly to Arwood.

Steel Casting Design. Atlantic Steel Castings Co., illus. Offers detailed information on how to economically design steel castings. **54**

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Thermometals and Special Alloys. H. A. Wilson Div., Engelhard Industries, Inc., 113 Astor St., Newark 2, N. J., 192 pp, price $3. Blue Book on thermostatic bimetals, sintered metals, electrical contact materials, composite and laminated metals and special alloys. Write on company letterhead directly to Wilson.

Silver Welding Alloys. Eutectic Welding Alloys Corp., 24 pp, illus., No. TIS-2840. Properties and uses of silver alloys for joining metals. 124

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Fabricating Nickel-Base Alloys. Haynes Stellite Co., Div. of Union Carbide Corp., 36 pp, illus. Procedures and recommendations for welding, forging, forming, machining, grinding, brazing, heat treating, descaling and pickling a group of nickel-base alloys called Hastelloy. 158

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Metal Powder Parts. U. S. Graphite Co., Div. of Wickes Corp., Saginaw, Mich., illus., No. 21. Properties, uses and dimensions of Dramix metal powder parts. Write on company letterhead directly to U. S. Graphite.

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ABS Rigid Plastics Pipe. American Hard Rubber Co., Div. of Amerace Corp., 16 pp, illus., No. CE-80. Corrosion resistance, fabrication data, dimensions and uses of ABS (acrylonitrile-butadiene-styrene) rigid plastics pipe, fittings and valves. 168

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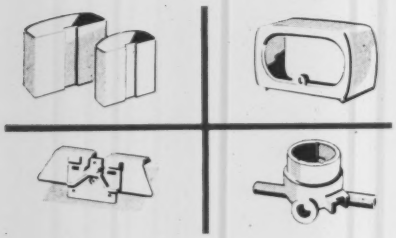

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Take a look at the characteristics listed here. Remember—you'll get maximum benefits when you design to utilize its high-strength, corrosion resistance, and consistently high quality to the utmost. It's easy to use, too . . . pulls apart readily to load in molds, and has long stability in storage.

MOLDED PROPERTIES

Specific gravity	1.87
Flexural strength, psi	
*ASTM bar	20,000
**Cut specimen	16,000
Flexural modulus (psi x 10^6)	1.6
Izod impact-notched, ft./lbs./in. notch	
*ASTM bar	12.0
**Cut specimen	4.5
Compressive strength, psi	18,000
Heat distortion point, 264 psi	>450° F.
Barcol hardness	65
Water absorption, %	
24 hours @ 23° C.	0.14%
24 hours @ 100° C.	0.75%

*ASTM bar—Test results achieved with a sample molded under ideal laboratory conditions to achieve maximum strength.

**Cut specimen—Test results achieved on a number of samples cut from molded parts at random direction to any possible glass alignment. Results reported are the average of several tests.

NOTE: Common practice reports test results in terms of the maximum values available under ideal conditions "ASTM bar" figures are listed here to permit comparison of Thermaflow 105 with other similarly reported materials.

ELECTRICAL PROPERTIES

Arc resistance, sec.	130 sec.
Dielectric strength (⅛" thick)	
v/mil short time	230 v/m
step by step	210 v/m
Dielectric constant (1 mc.)	5.05
Dissipation factor (1 mc.)	0.009

STRENGTH RETENTION

	Flexural Strength, psi	Flexural Modulus x 10^6	Appearance
Original sample	16,000	1.58	—
24 hours H_2O @ 100° C.	After Test 13,400	After Test 1.21	excellent
24 hours 10% boiling NaOH	13,800	1.09	good
24 hours 10% boiling HCl	10,500	0.87	surface good—pigment bleached white

Price Schedule (f.o.b. Wilmington; Net 30 days)

Standard Colors: grey, tan, black

1 carton — (80 lbs.)	— $ .64/lb.
5 cartons — (400 lbs.)	— .48/lb.
24 cartons — (1,920 lbs.)	— .42/lb.
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For free technical literature on all kinds of engineering materials, forms and finishes, see pp 45-49.

600° to 1000° F.

HIGH STRENGTH AND STABILITY

WITH GOOD FABRICATION PROPERTIES

AM 350 and AM 355 are metals for the space age! The combination of easy fabrication with high strength-to-weight ratio of AM 350 and AM 355 interests missile and supersonic aircraft designers with problems of high strength at elevated temperatures.

This pair of precipitation hardening stainless steels from Allegheny Ludlum research are easy to fabricate in the annealed condition. They can be spun, drawn, formed, machined, brazed and welded using normal stainless procedures.

Both alloys have high strength without embrittlement from room temperature to 1000°F, plus good ductility at elevated temperatures. They have remarkable stability and excellent corrosion resistance.

AM 350 is available in sheet, strip, foil, small bars and wire. AM 355, best suited for heavier sections, is available in forgings, forging billets, plates, bars, wire, sheet and strip.

For further information, see your A-L sales engineer or write for the new technical booklet, "AM 350 and AM 355," **Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.**

•22

ALLEGHENY LUDLUM

EVERY FORM OF STAINLESS . . . EVERY HELP IN USING IT

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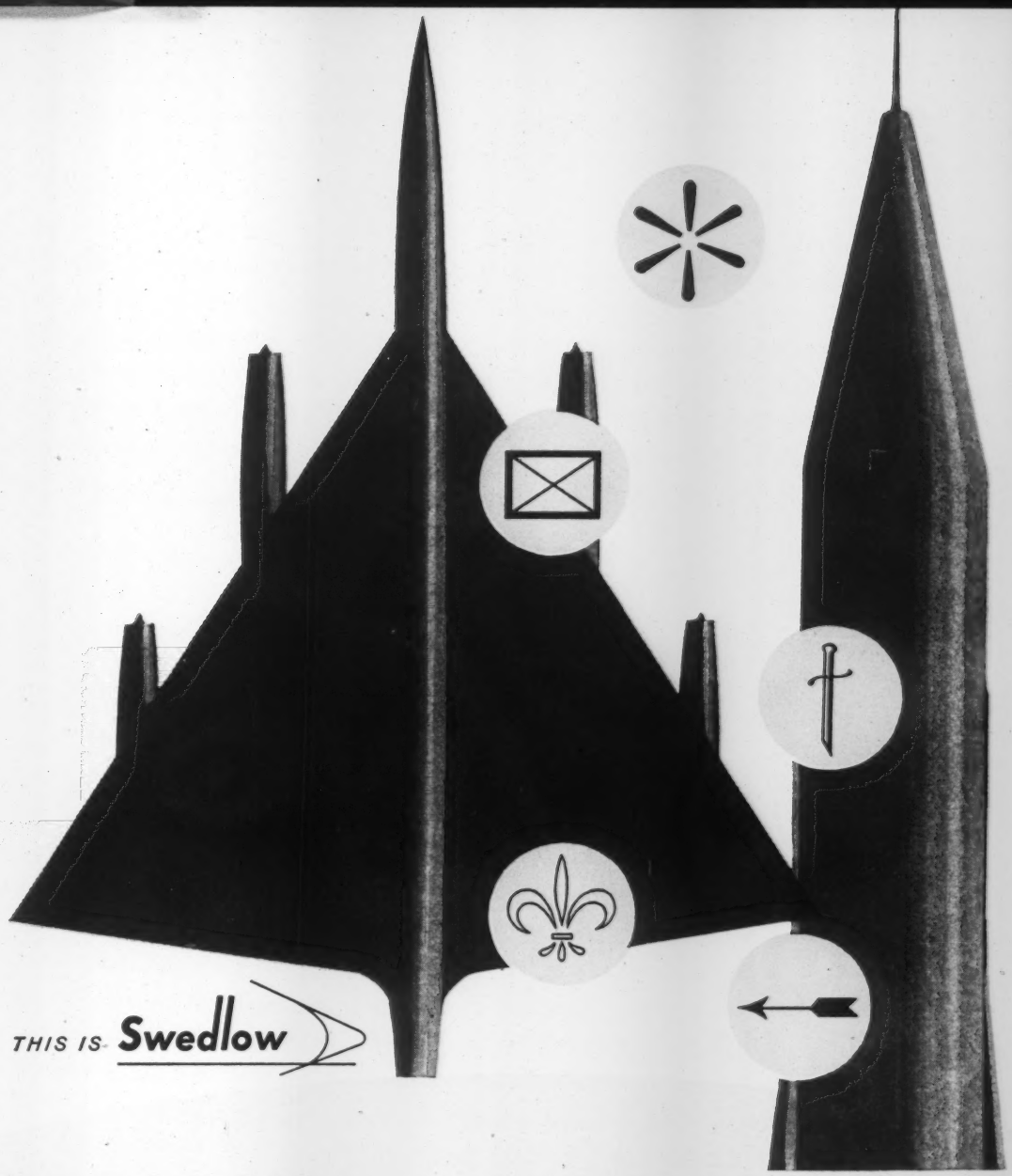

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High Temperature Welded Stainless Steel Honeycomb Core. Wide variety of materials and sizes to rigid specifications, produced on automatic machines. Light, strong, temperature and corrosion resistant, for bulkheads, fins and many other structural assemblies. **High Temperature reinforced plastic parts and laminates.** Wide variety of combinations to meet exact needs. Flat sheets or compound shapes. Minimum weight and bulk. Heat resistant. For nose cones, exit cones, ducting, shielding. **Metallized heat reflective laminates.** Gold and aluminum coatings increase radiant heat resistance to over 1650°F. Flat sheets or compound shapes. Light, strong; for radiant heat, heat shielding, exhaust heat damping. **Reinforced plastics.** Continuous and press made sheets and molded parts to meet individual requirements. Applications include mechanical, electrical, electronic, phototemplate, decorative, aircraft cargo liners, and many others. **Plastic Glazing.** Stretched, as-cast, monolithic and laminated acrylic windows, canopies, windshields, with emphasis on high temperature glazing applications. Optically polished, tough, light weight, resistant to fracture.

WRITE for technical information specifying materials of your interest. Please refer to Dept. 18.

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SALT WATER CORROSION

How Lukens *Application Research* can help you find the right steel plate for the job

Among other materials, our Application Engineering staff has studied the outstanding nickel alloy, Monel, in a variety of salt water applications. Monel is surprisingly economical when used in clad plate form—a Lukens specialty produced by bonding a layer of Monel to a tough, low-cost carbon steel backing plate.

The massive legs of off-shore radar platforms, for example, are protected by Lukens Monel-clad steel plate. Our engineers recommended this shielding for the critical splash areas extending above and below the water line. It has proved a most successful application.

Salt water swimming pools on ocean liners, traditionally of tile, often require extensive repair between voyages. We helped solve this problem for a well-known steamship line—again with Monel-clad steel plate. Beautiful to look at, these sea-going pools need only routine cleaning and maintenance. Many are now in service—others are being built, including one for the nuclear powered *Savannah*.

If your assignment is salt water corrosion, let it be our assignment, too. Lukens Application Engineers have documented cases covering a wide range of materials selection problems—to help you choose the right steel plate.

Contact Manager, Application Engineering, D129 Services Building, Lukens Steel Company, Coatesville, Pa.

Helping Industry Choose Steels That Fit The Job

LUKENS

ASK FOR THE BULLETIN ON LUKENS CLAD STEELS

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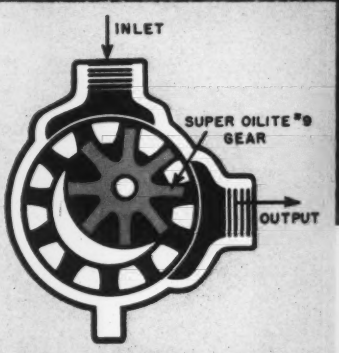
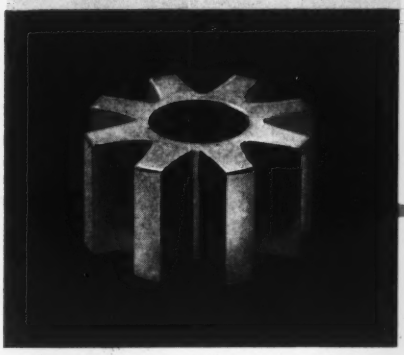
HAHN 'HI BOY' SPRAYER





Double Sprayer Output, Cut Costs 75% with Oilite Precision Gear

The search for a more durable star gear at less cost led Hahn, Inc., Evansville, Indiana to investigate Amplex powder metallurgy. Amplex engineers came up with an answer that far exceeded Hahn's expectations.

Formerly machined from cast bronze, the gear is now produced in a single press operation of hardened Super Oilite No. 9†. By eliminating scrap and machining operations like turning, boring, cut-off and hobbing, Amplex reduced the cost of the gear approximately 75%. But that's not all . . .

Despite exposure to acid-forming, gritty fertilizers and pesticides, the oxide-coated Oilite gear proved 5 times more durable than its predecessor! Tough Super Oilite No. 9 proved so remarkably wear-resistant, Hahn was able to double the pump's gpm output.

What do *you* look for in components—lightweight, close tolerances, corrosion resistance, wear resistance or superior surface finish? Amplex can supply quality-controlled parts in volume that meet *all* of these requirements.

To put superior performance at less cost into your products, contact the nearest Oilite Engineer. Look for him in the Yellow Pages under "Bearings" or write Department T-12.

† Only Chrysler makes Oilite

QDP or PDQ?*

Why risk excessive production and warranty costs? You can depend on Amplex for top *quality* components, prompt *delivery* and a reasonable *price* . . . QDP! The result is parts that reduce your manufacturing and selling costs.

* Quality-Delivery-Price vs. Price-Delivery-Quality

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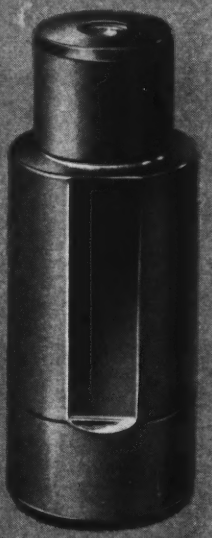
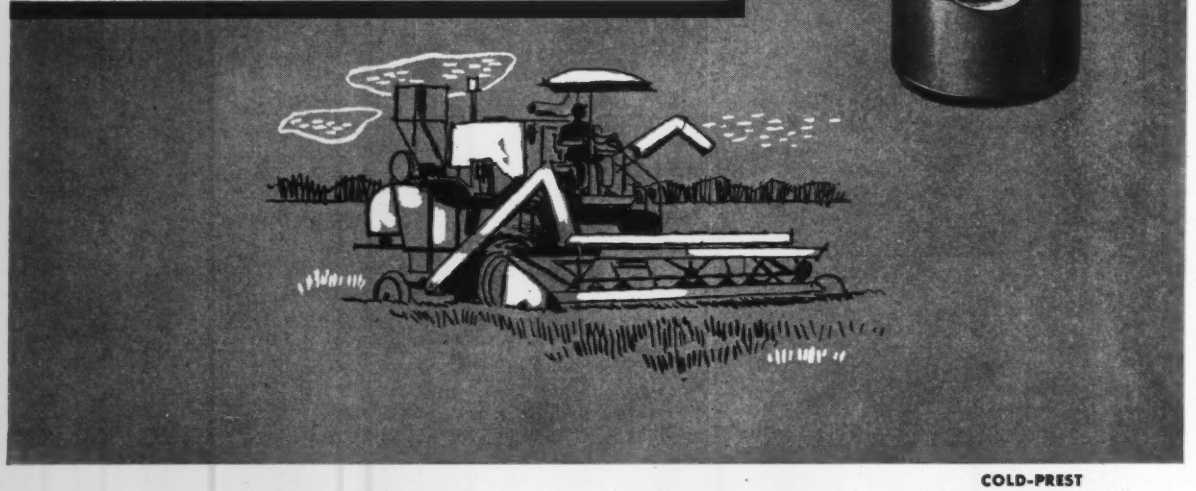
two more cases where PARTS PRODUCED FROM provide excellent bearing properties

CASE HISTORY

MUELLER BRASS CO. 600 ALLOY screw machine product used in heavy duty farm equipment

This heavy duty planetary pinion shaft, made as a screw part from tough "600" series bearing alloy, was the answer to a continuing wear problem encountered in the driving mechanism of heavy-duty farm equipment and big trucks. The part is machine produced to exacting tolerances and all necessary finishing operations are done by Mueller Brass Co. so the pinion shaft is ready for installation when received. Since "600" alloy parts have been installed, no operating failures have been reported and the shafts have proved far superior to the material formerly used.

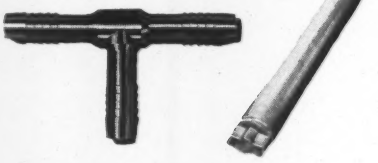




MUELLER BRASS CO. ANALYSIS SERVICE

You get sound, unbiased advice on the one best method of making your parts because Mueller Brass Co. is the only fabricator in the country offering all these methods of production. An experienced Methods Analysis Department has at its command a complete knowledge of the advantages and limitations of each production process. This unique technical service is your assurance of getting the best product at the best price . . . made the one best way!

COLD-PREST IMPACT EXTRUSIONS



PLASTIC INJECTION MOLDING

MUELLER BRASS CO.

MUELLER BRASS CO. 600 ALLOY

and maximum wear resistance in tough applications

CASE HISTORY

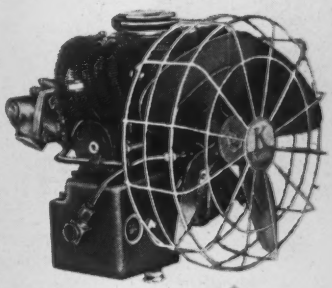
MUELLER BRASS CO. 600 ALLOY forgings used in aviation air compressors

Analyzing the job requirements of Walter Kidde & Company, Inc., for a main driving cam component to be installed in a reciprocating type of aircraft air compressor, Mueller Brass Co. Methods Analysis Engineers decided on a forging fabricated from "600" alloy as the most practical method of production. Since the cam forms the prime component of the driving mechanism, it must have good bearing wear surfaces and because the compressors are used in the aviation industry, the cams must be completely dependable. The close grained, strong forging that resists combination compressive and tensile stresses was the answer.

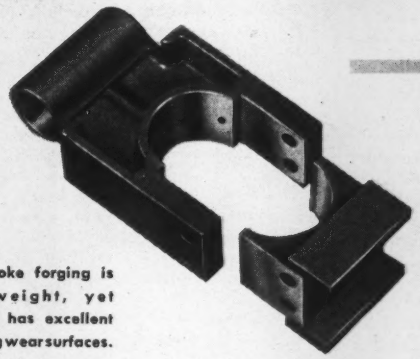
A typical compressor takes in ambient air and compresses it to 3000 psi or higher. This high pressure air is stored in metal or fiberglas containers until needed for actuation of pneumatic system components such as solenoid control valves, brake valves, manual control valves or actuators. These and other pneumatic units retract the entrance door, operate landing gear, wheel brakes, nose wheel steering systems, propeller brakes or perform other functions.

Aircraft in which Kidde compressors are installed include the Boeing 707, the Douglas DC-8, the Lockheed Electra, the Fairchild F-27 and various military aircraft.

Mueller Brass Co. produces press, hammer or cored forgings of any practical shape from a few ounces to 150 lbs. in brass, bronze, aluminum and magnesium in 27 standard, as well as special, alloys.

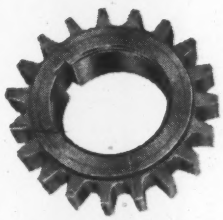


Aircraft air compressor equipped with hydraulic drive delivers air compressed to 3000 psi at the rate of 6 cfm.



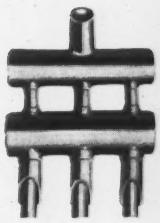
This yoke forging is lightweight, yet strong; has excellent bearing wear surfaces.

Forging is part of the main cam, the prime component of a modified Scotch-type yoke, which is the piston driving mechanism in the air compressor.



POWDERED METAL PARTS

SAND CASTINGS



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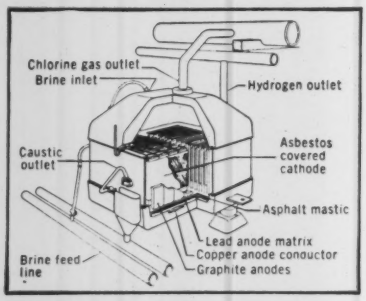
the LEAD newsletter

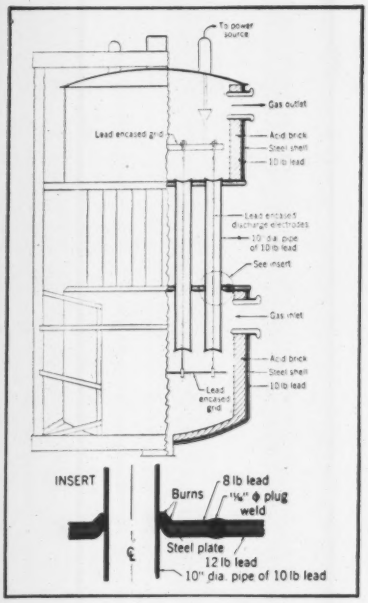
Lead The Safest Shielding In Portable Atomic Reactor

Engineers of Atomics International, a division of North American Aviation, Inc., have taken advantage of the unusual properties of lead as a reflector shield in a small "shippable" 5-watt research reactor. Designed for schools or medical and industrial laboratories, the reactor features a 6-in. thick lead neutron reflector-primary shield weighing approximately 3,800 lbs. This shield surrounds the core vessel containing aqueous uranyl sulphate, an homogeneous fuel suspension. It is purportedly the first reactor to employ lead as the only reflector material. Especially where mobility is important, lead for shielding purposes offers the best overall combination of design properties.



Conductivity Important In Hooker Electrolytic Cells

Practically all of the caustic soda and chlorine manufactured in the United States is made by the electrolysis of sodium chloride brine. Hooker Chemical Corp., which developed the cells shown here, produces over 35% of the nation's supply. The bottom section of the Hooker cell contains graphite blades cast in a lead matrix; lead is used as a coupling between the graphite blades and copper conductors of the cell's anode section. Chemical lead, containing less than 1% antimony, gives such excellent conductivity that the voltage drop at high amperages results in very nominal losses. Quality is important too, in obtaining the necessary dimensional stability and an efficient graphite-lead joint. Most of the 2,500 lbs. of lead used in each cell is recovered by melting the matrix in a furnace.



Lead Protects Electrostatic Precipitators Against Sulphuric Acid Attack

These electrostatic precipitators for Stauffer Chemical Company produce fresh, clean, strong sulphuric acid from refinery sludges and spent acids. As does most equipment of this type, these precipitators rely on the excellent resistance of lead to sulphuric acid attack to protect their structural components. In fact, the interior is completely protected by lead with the exception of the roof of the upper chamber, which is rubber lined.

Lead Proves Effective Protection From Gamma Radiation

Cities Service technicians are protected by lead while investigating the effect of radiation induced ionization reactions on petrochemical processes and products. Experiments are conducted while technicians are protected by 42 in. of leaded glass weighing 7,500 lbs. Nearby, a 12 in. thick lead door encloses 3 lbs. of Cobalt 60, which was transported to the site in a 6,000 lb. lead cask. This is only one example of lead's widespread use in isotope shipment, receipt, handling, and utilization throughout the country.

Lead Shield In Naval Nuclear Reactor

Over 20 tons of lead are included in the shield of the "Modified Swimming Pool" research reactor at the Naval Research Laboratory in Washington, D. C. The reactor, used for investigations in the physical sciences, provides an intense source of neutrons and gamma rays. It was placed in the pool to allow scientists to study radiation shielding problems of nuclear reactors for ship propulsion and electric power generation. Lead – widely considered in the field of nuclear energy as one of the basic shielding materials – is used here to absorb much of the gamma radiation from the core.

Many Uses For Lead

In addition to its use in reactors and portable radiographic equipment where compactness is desired, lead is widely used in atomic laboratories . . . in hospitals . . . and wherever there is a necessity for shielding against gamma rays. This is only one facet of lead's versatility. Leaded glazes put the gleam on wall tile, building bricks and fine china . . . lead paints guard against marine and atmospheric corrosion . . . and even help imitate mother-of-pearl.

If you have a new product or a problem that lead in its many forms may be able to help you solve, please write for the free advice of our scientists. Write to: *Office of Technical Information, Lead Industries Association, 60 East 42nd Street, New York 17, N.Y.* 1972

LOOK AHEAD WITH LEAD

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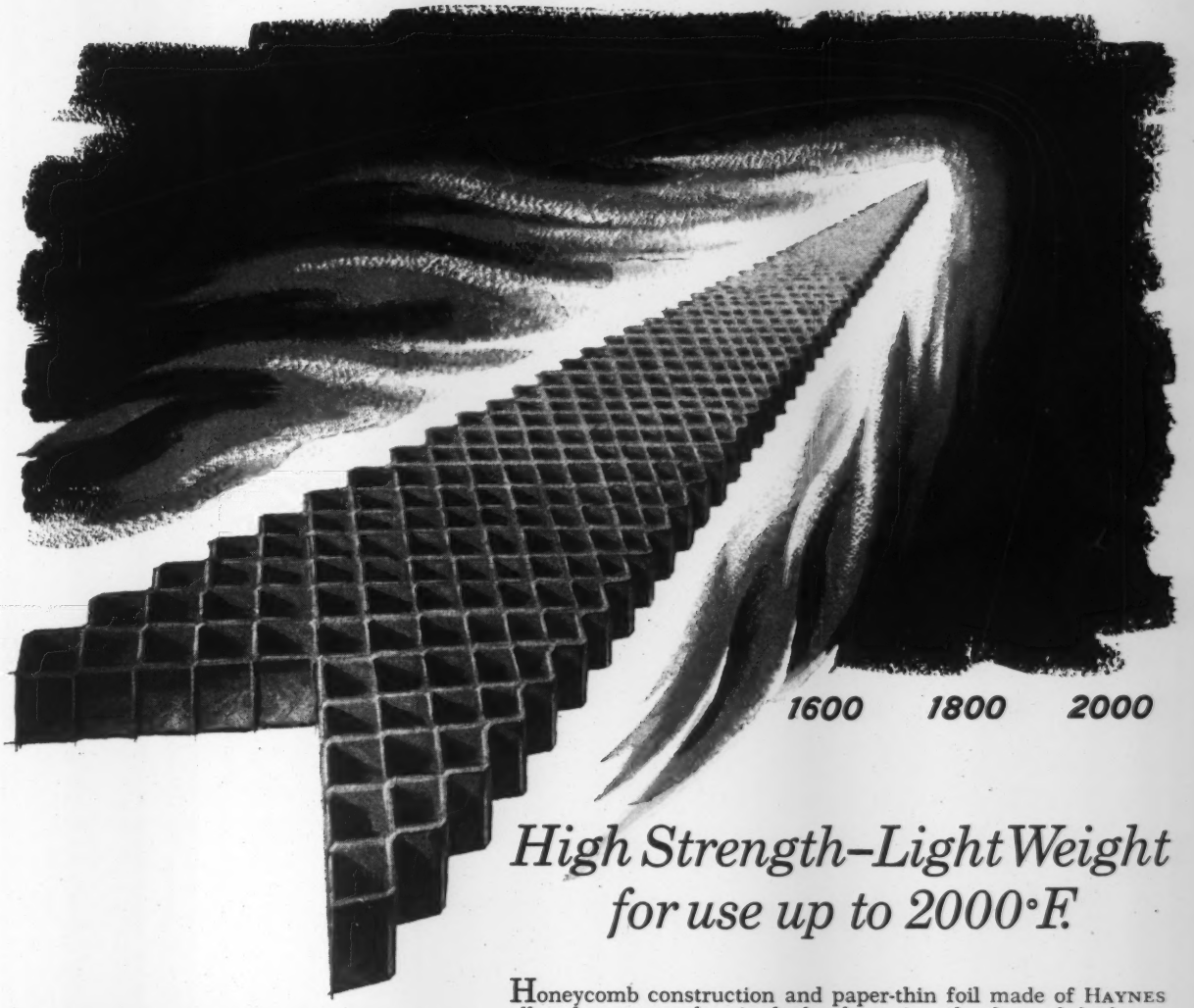
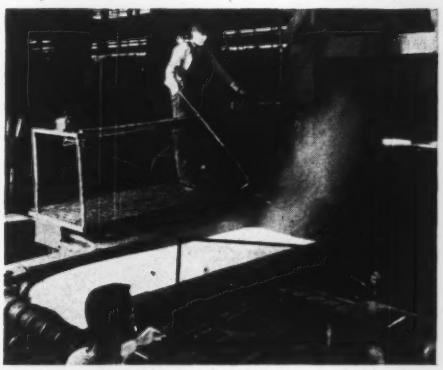


High Strength–Light Weight for use up to 2000°F.

Honeycomb construction and paper-thin foil made of HAYNES alloys have teamed up in the battle against the thermal thicket. The result? a strong, lightweight material that resists temperatures in the 2000+ deg. F range. A material that enables engineers to design parts with exceptional heat-resistant characteristics and with high strength to weight ratios; components that equal the high-temperature resistance of solid sections, yet weigh only 1/10th as much.

Foil as thin as 0.002 inch is now available in HAYNES alloy No. 25, HASTELLOY alloy X, and MULTIMET alloy. It can be obtained as foil, for use in engine blanketing for example, or in honeycomb form.

HAYNES high-temperature alloys are produced in many other forms, too. Sheet, plate, bar stock, wire, tubing, and castings are all immediately available. For full information, write for descriptive literature.



High quality and availability of HAYNES wrought alloys are assured because they are produced in our own plant by experts. Sheet, above, is being hot-rolled on a 3-high mill.

HAYNES ALLOYS

HAYNES STELLITE COMPANY

Division of Union Carbide Corporation
Kokomo, Indiana

UNION CARBIDE

The terms "Haynes," "Hastelloy," "Multimet" and "Union Carbide" are registered trade-marks of Union Carbide Corporation.

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seal better and last longer in actual use!

Perhaps you can't **SEE** the difference or **FEEL** the difference, but comparison tests prove that Parker-O-Rings are **better.** Exhaustive research, experimentation and development, **plus** uncompromising standards of manufacture assure consistent accuracy of both materials and dimensions. So when you need O-rings, be **SURE** — specify **PARKER.** Most sizes are carried in stock ready for immediate delivery.

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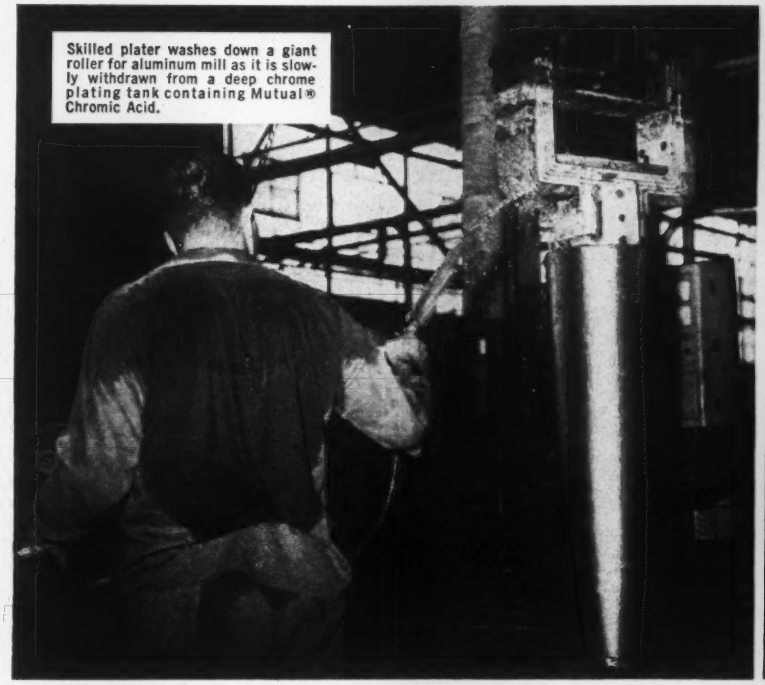
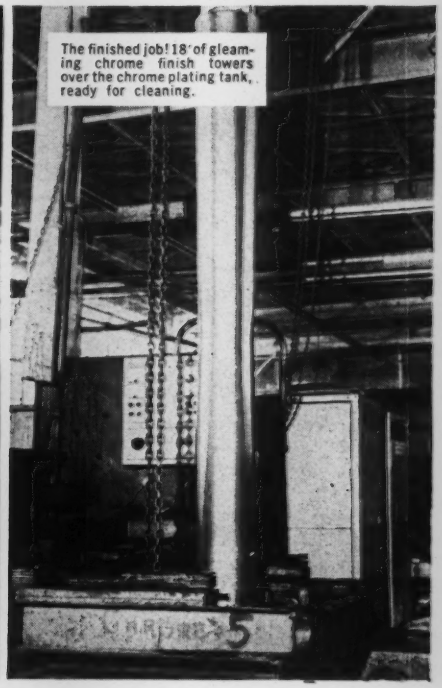


Skilled plater washes down a giant roller for aluminum mill as it is slowly withdrawn from a deep chrome plating tank containing Mutual® Chromic Acid.



The finished job! 18′ of gleaming chrome finish towers over the chrome plating tank, ready for cleaning.

Simmons Vertically Plates 18′ Roller For Aluminum With MUTUAL CHROMIC ACID

Being *vertically* chrome plated for use on the world's largest rolling mill — a 170-inch-wide reversing mill at the Reynolds Metals Company Alloys Plant, Listerhill (Sheffield), Alabama—are giant steel rollers for carrying aluminum ingots.

The Simmons Plating Works of Atlanta, Georgia immerses each roller in a 28′ deep chrome plating tank containing Mutual Chromic Acid. The vertical plating process provides a faster, better quality plating job over the entire surface of the roller. Each roller is plated to .005″ minimum thickness in a standard 33 oz. per gal. chromium plating solution at normal plating temperatures of 130°F.

Like many other skilled platers throughout the country, Simmons relies on high purity Mutual Chromic Acid to provide a chrome plate that gives longer wear and resistance to rust and corrosion. Plating with Mutual Chromic Acid also helps to protect the rollers from damaging or scratching the aluminum ingots they convey.

Mutual Chromic Acid is always 99.75% pure—or better. Sulfate content never exceeds 0.1%. Rigid quality control insures that the chromic acid you get is always the same. This makes it easier for you to control accurately the chromic acid-sulfate ratio of your plating bath.

For information on Mutual Chromic Acid, as well as other Mutual chromium chemicals, send coupon for our free booklet, "Chromium Chemicals." Our Technical Service staff will also be happy to answer your questions.

OTHER PRODUCTS FOR PLATERS

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MUTUAL chromium chemicals are available through dealers and SOLVAY branch offices located in major centers from coast to coast. Send export inquiries to Allied Chemical International, 40 Rector St., New York 6.

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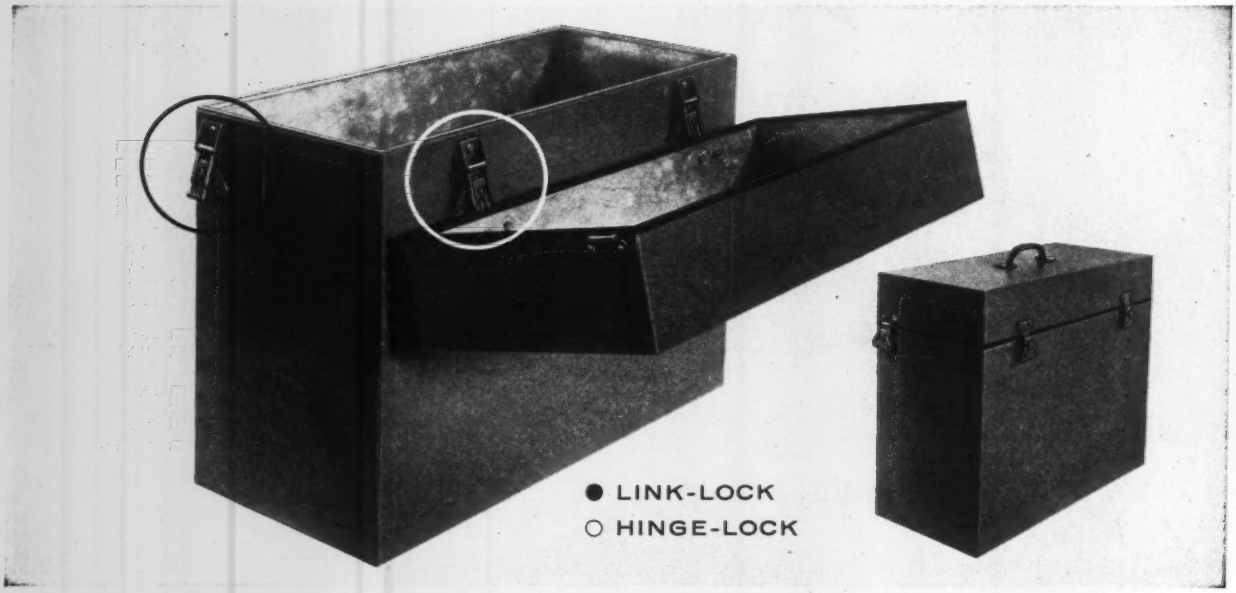
An all-around pressure-tight seal for hinged-cover transit cases with

LINK-LOCK and HINGE-LOCK



No. 3 LINK-LOCK

No. 3 HINGE-LOCK

Two HINGE-LOCK and two LINK-LOCK Fasteners provide all-around sealing pressure on this container manufactured for the U.S. Navy by the Bonded Structures Division, Swedlow Plastics Company.

The new Simmons HINGE-LOCK, used in combination with LINK-LOCK, provides an even, pressure-tight seal on equipment containers and transit cases with hinged covers. A half-turn applies pressure to both types of fasteners. When pressure is released HINGE-LOCK becomes a free-operating hinge, and LINK-LOCK disengages to permit opening.

Originally developed by Simmons Fastener Corp. for the Engineering Department of Swedlow Plastics Company, Bonded Structures Division, HINGE-LOCK is similar in principle and appearance to LINK-LOCK. Both are available in light and medium duty sizes as matched hardware. LINK-LOCK is also available in a higher-capacity, heavy-duty size.

SEND TODAY for complete data, including dimensions, capacities. Engineering service is available... Outline your requirements. Samples on request.

See our 8 page catalog in Sweet's Product Design File

SIMMONS FASTENER CORPORATION 1759 North Broadway, Albany 1, New York

QUICK-LOCK • SPRING-LOCK • LINK-LOCK • HINGE-LOCK • ROTO-LOCK • DUAL-LOCK

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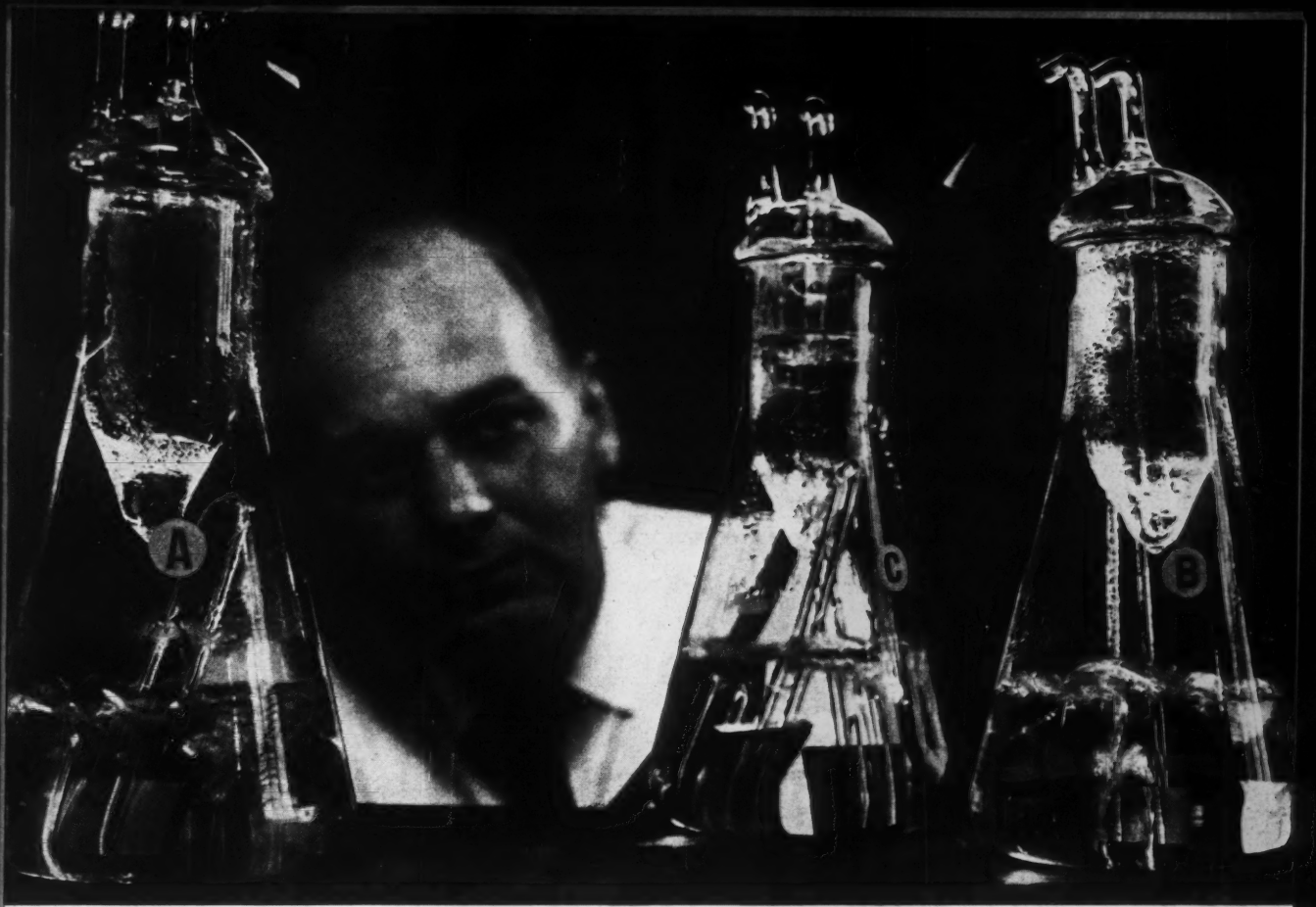

Here, boiling nitric acid is used to evaluate the corrosion resistance of Jessop stainless steel plate.

"How Jessop Tests Stainless Steel in Boiling Nitric Acid"

L. W. Cooper, Chief Metallurgist

"From experience, our customers know this is a fact: Specify Jessop for specialty steels . . . and then relax! Of the many reasons *why* this is true, here's one . . .

"In evaluating corrosion resistance, one of the procedures we use is the ASTM boiling nitric acid test. Standard and simple? Yes. But expert *evaluation* is of great importance to the customer. That's why, at Jessop, a top metallurgist closely supervises each of the five 48-hour test periods.

"*Overly cautious?* Because we're overly cautious in *every* phase of steel production and quality control, Jessop has earned the reputation for producing specialty steels tailor-made to the most exacting specs — *Specify Jessop . . . and then relax!*"

Checking the grain size of tool steel, this Jessop metallurgist uses a microscope with a camera attachment. VMA 6787

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STEEL COMPANY
Washington, Pennsylvania

Stainless, alloy, tool, cast-to-shape, clad, and forging steels, ground flat stock and other specialty steels

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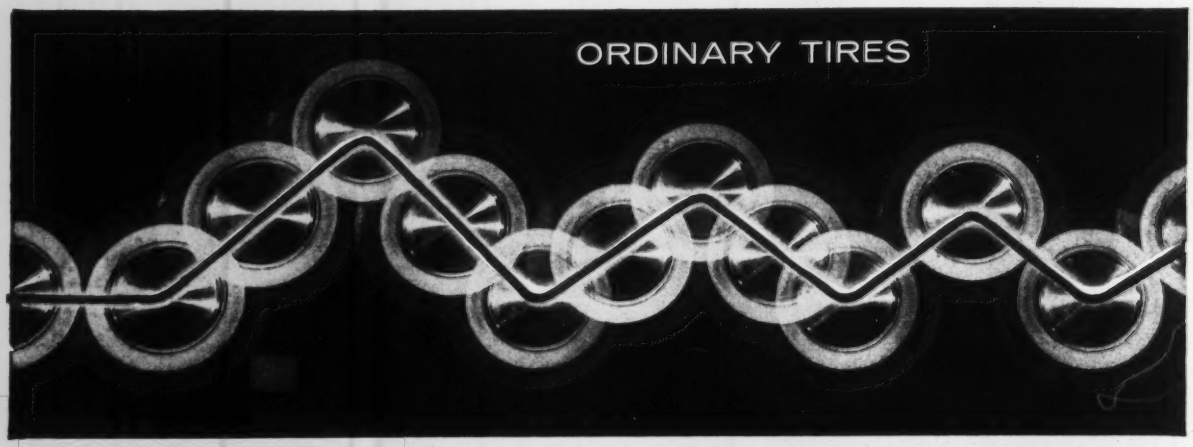

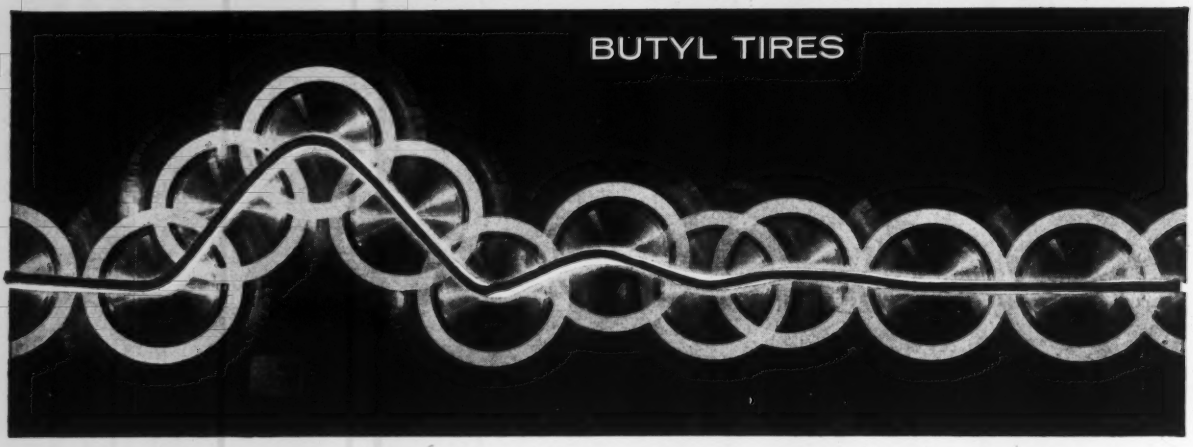

World's first "screech-free" tires made of

ENJAY BUTYL!

Save costly design improvements

•Because Butyl absorbs shock better than any other rubber, dramatic improvements in suspension and silence of ride are now made possible with revolutionary Butyl tires. Comments from design engineers in Detroit indicate Butyl tires will eliminate, or at least minimize major engineering changes to overcome vibration and noise.

And what a powerful new selling feature! Butyl tires give such remarkable road traction, they refuse to squeal, at any corner, at any speed – even on hot pavements. And they stop up to 30% quicker – even stop faster on wet surfaces than ordinary tires do on dry.

In addition to 100 other Butyl parts, tomorrow's best-selling cars will have tires of Butyl. One short demonstration ride can prove that any car equipped with Butyl tires gives traction, safety, and silence never experienced before. Butyl tires are now available to the motoring public. Let us show you how Butyl can help make better rubber products.

For complete information
Write or phone your nearest Enjay office. Enjay's laboratories and expert staff are always glad to provide technical assistance on request.

EXCITING NEW PRODUCTS THROUGH PETRO-CHEMISTRY

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ENJAY® BUTYL

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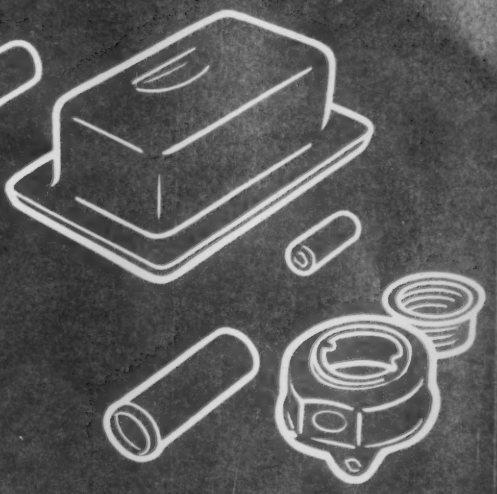
SCOVILL



has a word for the wise aluminum fabricator

THE WORD IS...

Truspec®

THE WELL-BEHAVED ALUMINUM SHEET

Aluminum is not new to Scovill. We were one of the very first mills in the country to start processing this new metal when it became commercially available in the late 1880's. But commercial Aluminum Sheet produced to the same closely controlled specifications Scovill established for Brass Strip was a NEW IDEA when we introduced TRUSPEC Aluminum.

Fabricators have long wanted Aluminum like this . . . because it can so effectively help them control such common problems as "earing" and "orange peel" effect . . . because it can reduce time-consuming adjustments and promote longer tool life . . . because Scovill has made available long-length coils (up to 100 lbs. per inch of width) and the sheet itself is remarkably uniform in gauge, from side to side and end to end.

Scovill believes the customer now gets what he wants . . . in TRUSPEC Aluminum Sheet identified by this Trademark.

it PAYS to specify...

BRASS • COPPER • ALUMINUM

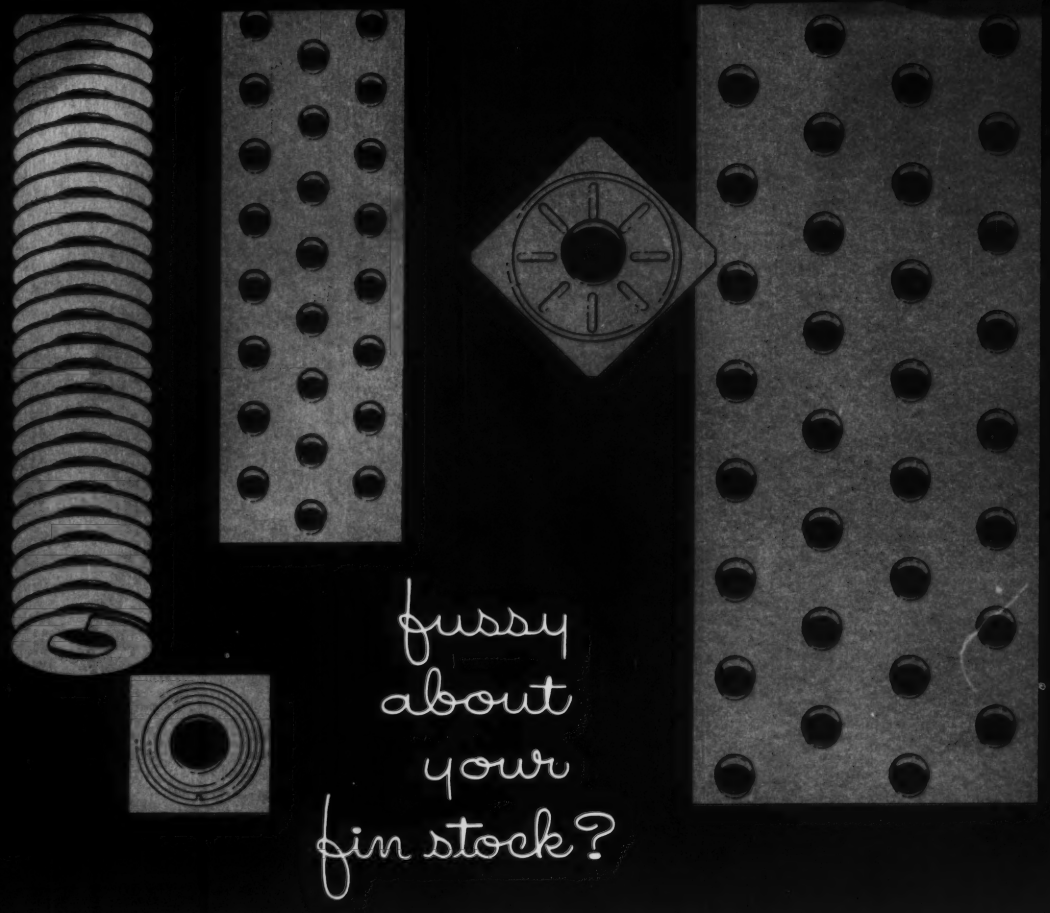
MILL PRODUCTS

identified by this trademark

made better to bring out the BEST in your products

Scovill Manufacturing Company, Mill Products Division, 99 Mill St., Waterbury 20, Conn. Phone PLaza 4-1171.

3SC59



Sure you are!

and you'll find just what you want in

SCOVILL

Truspec®

ALUMINUM

The WELL-BEHAVED Aluminum Sheet

15SC59

TRUSPEC Aluminum Fin Stock, combining superior uniformity in the sheet, side to side and end to end, as well as close tolerance adherence to customers' tight specifications, can help fabricators speed their operations and achieve superior heat transfer components.

SPECIAL INTERMEDIATE TEMPERS, to permit just the right degree of stiffness and workability, dead softness or ample rigidity, are a Scovill specialty.

No matter what methods of fabrication and assembly you are using, let Scovill Technical Service suggest a better fin stock specification ...SCOVILL TRUSPEC ALUMINUM SHEET.

made better to bring out the BEST in your products

SCOVILL MANUFACTURING COMPANY, Mill Products Division, 99 Mill Street, Waterbury 20, Connecticut. Phone PLaza 4-1171.

ARMCO ENAMELING IRON

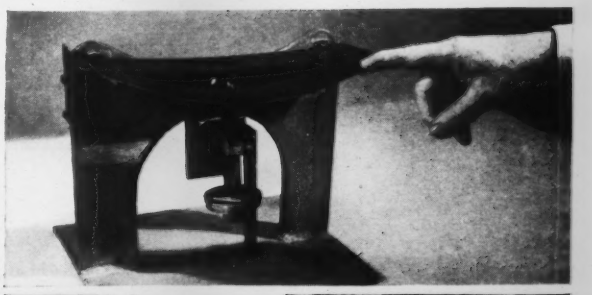
resists sag, reduces defects, helps you sell

New steels are born at Armco

It's made only for porcelain enameling

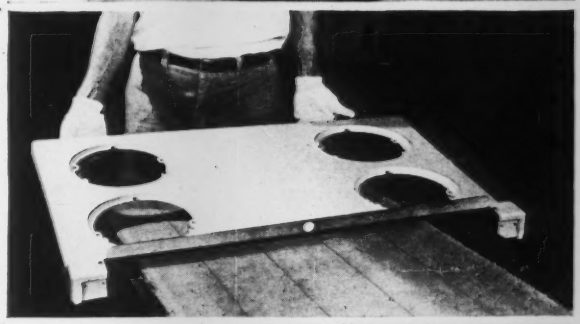
Resists sag

Fired at the same temperature, mild steel (front) droops badly, while Armco Enameling Iron (rear) stubbornly resists sag. With this special enameling base, critical dimensions of porcelain enameled parts stay accurate.



Fewer finish defects

Commercially-pure Armco Enameling Iron contains a minimum of gas-forming impurities. Because of its high purity, costly shop rejects for finish defects stay low.



Helps you sell

At point of purchase, where competing products often stand side by side, close fit of parts and defect-free finish help clinch sales.

For shop savings and showroom sales, specify top-quality Armco Enameling Iron. It's made *only* for porcelain enameling. Just send the coupon for complete information.

ARMCO STEEL CORPORATION
3009 Curtis Street, Middletown, Ohio

Please send me a copy of the catalog, "Armco Enameling Iron."

Name_____ Title _____

Firm_____

Street_____

City_____ Zone____ State_____

ARMCO STEEL

Armco Division • Sheffield Division • The National Supply Company • Armco Drainage & Metal Products, Inc. • The Armco International Corporation • Union Wire Rope Corporation

For more information, circle No. 499

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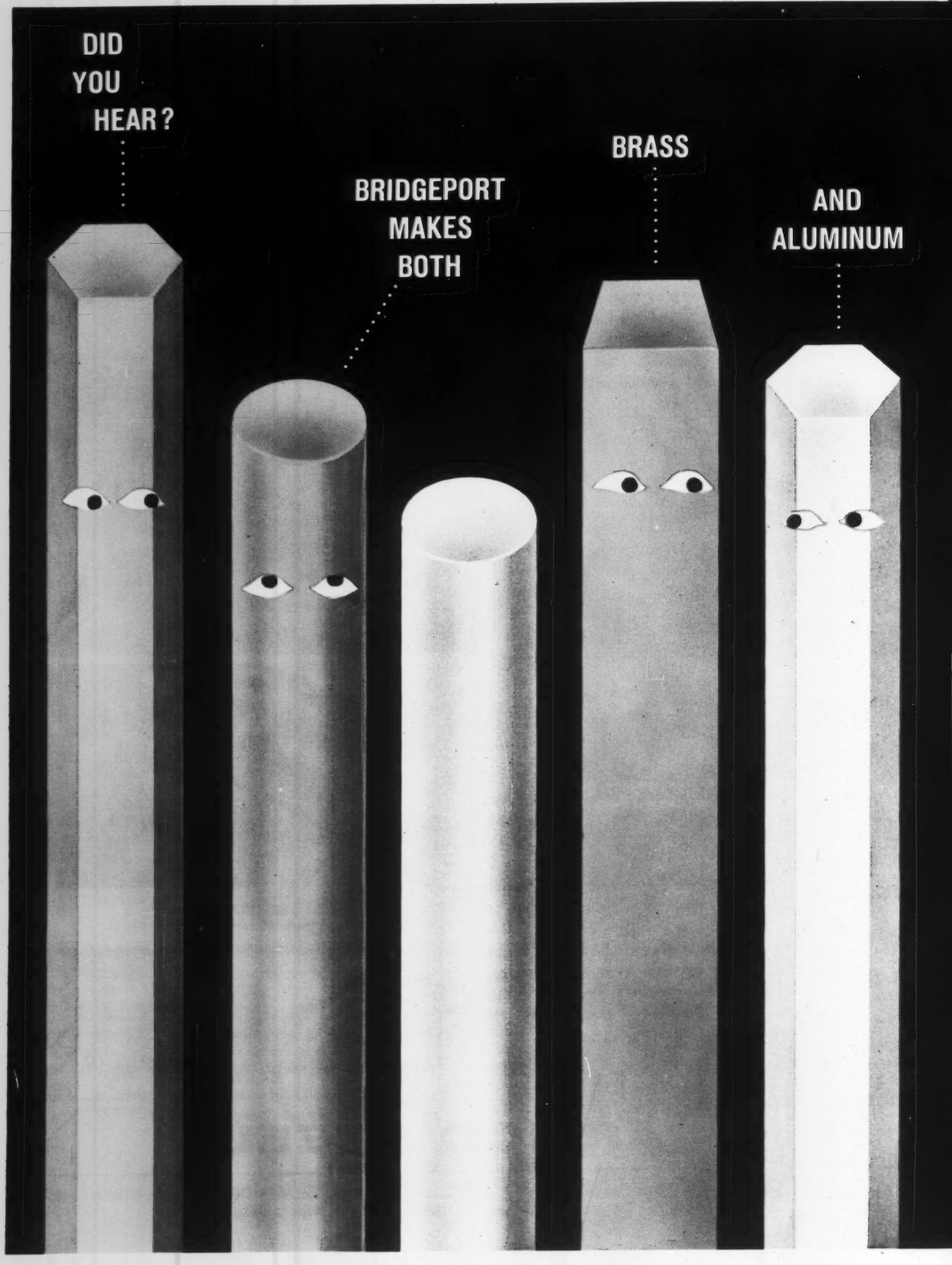
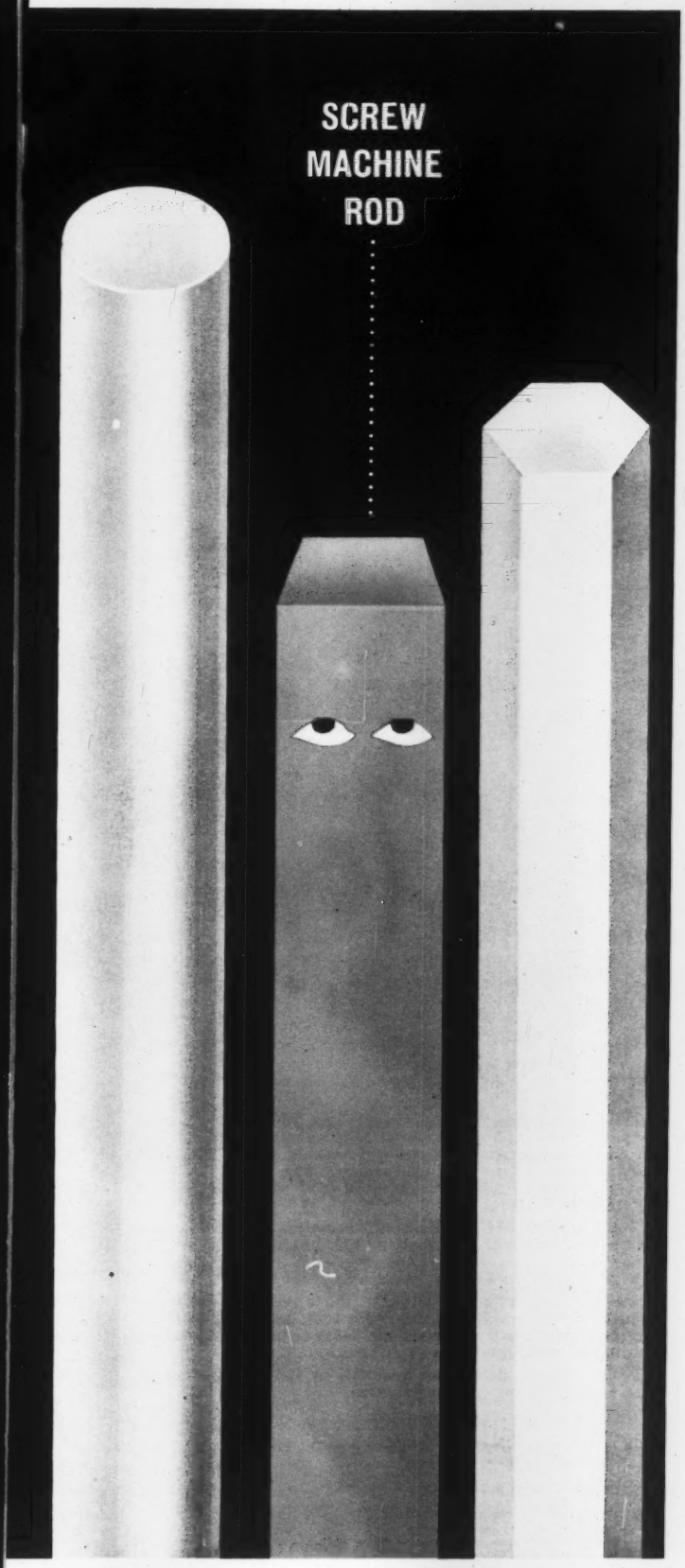

DID
YOU
HEAR?
BRIDGEPORT
MAKES
BOTH
BRASS
AND
ALUMINUM



BUY BRIDGEPORT SCREW MACHINE ROD

Bridgeport has no "metal axe" to grind. We recognize that for some applications aluminum is better... for others, brass is best. Our one objective is *to give you the most suitable material for your specific needs.* That's why you can always rely on the advice of your Bridgeport Salesman—he knows your screw machine needs and can give you the same high quality rod in aluminum or brass. He's backed by our 92 years of metals know-how and our pioneering work in developing high speed rods for the screw machine industry.

He can give fast service, too, because Bridgeport stocks both aluminum and brass screw machine rod in warehouses and mills throughout the country for immediate delivery. For full details, call your nearest Bridgeport Sales Office, or, write directly to Bridgeport Brass Co., Bridgeport 2, Conn. Dept. BA37

ALUMINUM SCREW MACHINE ROD

TYPES	Round and Hexagon.
SIZES	Diameters in 1/64" increments from 1/2" to 3" in standard 12-foot lengths.
ALLOYS	2011-T3 (Standard temper—heat treated and drawn) 2011-T8 (For applications requiring deep drilling—HT-Drawn-Aged) 2017-T4 (For applications requiring high strength) 6061-T6 (For applications requiring superior corrosion resistance) 2024-T4 (Heat treatable—for applications requiring high strength)

BRASS SCREW MACHINE ROD

TYPES	Round, half-round, oval, square, rectangular, hexagonal and special shapes.
SIZES	Diameters from 1/16" through 4-1/2".
ALLOYS	Free Cutting Brass; Leaded Commercial Bronze; Tellurium Copper; Sulphur Bearing Copper; Hardware Bronze; Leaded Muntz Metal; Leaded Naval Brass; Aluminum Bronze; Free Cutting Phosphor Bronze; Nickel Silver.

BRIDGEPORT TECHNICAL SERVICE is always ready to help you use metals to your best advantage—in reducing costs, improving alloys or solving your production problems on both brass and aluminum. Ask your Bridgeport Salesman or write to us direct for more details.

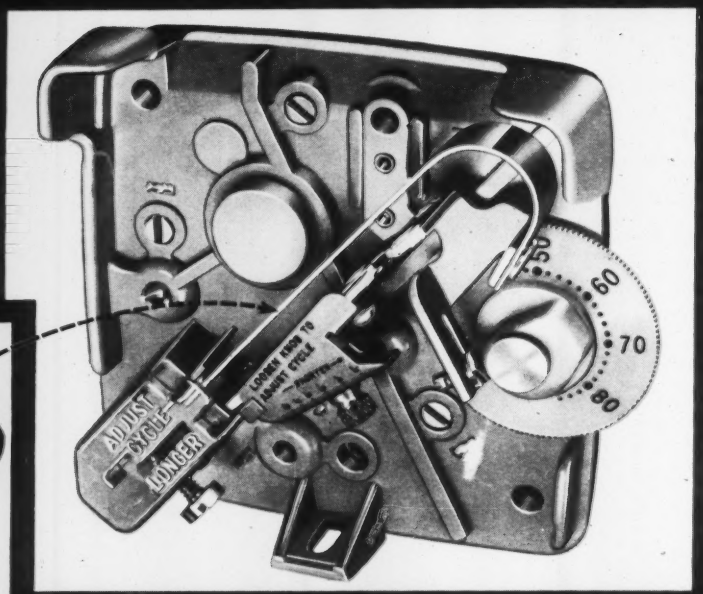
Bridgeport

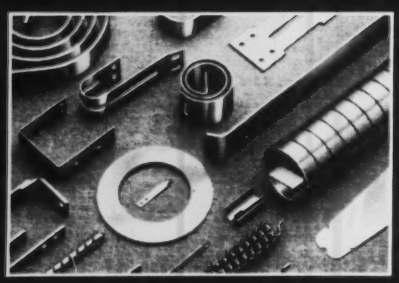
BRIDGEPORT BRASS COMPANY

Bridgeport 2, Conn. • Sales Offices in Principal Cities

Specialists in Metals from Aluminum to Zirconium

General Plate TRUFLEX Thermostat Metal Assures CONSISTENT SENSITIVITY AND ACCURACY... In SIGNET CONTROLS





A few typical Truflex fabricated parts

In designing its new attractive thermostat Signet Controls turned to General Plate for Truflex Thermostat Metal. Here's how Mr. W. D. Gibson, Manager of Signet Controls, puts it:

"The heart of a thermostat is the temperature-responsive element. In designing our new Model T500 we were careful to select a thermostatic material which would be consistently sensitive and accurate. Our previous experience assured us that we would obtain these vital characteristics with Truflex Thermostat material."

When you buy General Plate Truflex Thermostat Metal you can be sure that the first lot meets specifications 100% and every succeeding lot is a duplicate . . . has identical characteristics to the original . . . whether it be manufactured days, months or years later.

Advanced General Plate production methods insure positive consistency in tolerances, grain structures, expansion, hardness, etc. They assure maximum uniformity of materials which reduces costly rejects and guarantees highest quality performance.

Truflex Thermostat Metals are available as fabricated elements, assemblies and extra long coils or flat strip.

METALS & CONTROLS

1612 FOREST STREET, ATTLEBORO, MASS., U.S.A.

A DIVISION OF TEXAS INSTRUMENTS INCORPORATED

GENERAL PLATE PRODUCTS: Clad Metals • Electrical Contacts • Truflex® Thermostat Metal • Platinum Metals • Reactor Metals • Radio Tube & Transistor Metals

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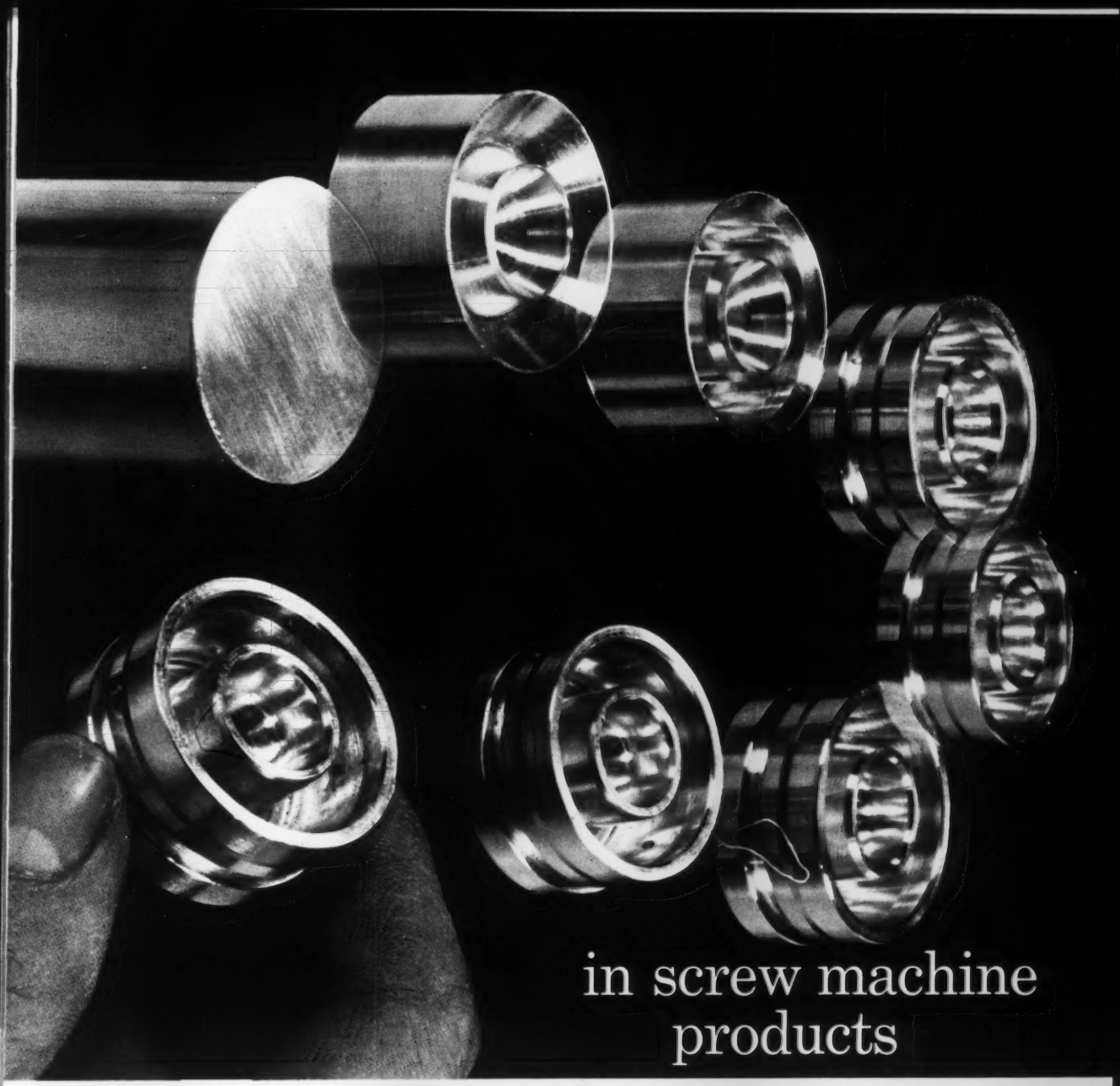


Alcoa puts the metal where you want it

This aluminum piston for an automotive air-conditioning compressor shows how far Alcoa goes to put the metal where you want it. Not just in primary screw machine operations, complex and demanding as they were, but on through a series of exacting secondary operations that enabled us to deliver a completely finished part.

Using $1\frac{7}{16}$-in. diameter 2014-T4 cold finished bar on a six-spindle automatic, we handled the forming, trepanning, drilling, facing and counterboring. Then we tackled the rest of the job—drilling and deburring two $\frac{1}{16}$-in. cross holes. This was followed by coining the ball seat at a specified tonnage in order to insure proper assembly without distortion. Centerless grinding was then performed to a total tolerance of half a thousandth of an inch (plus or minus 0.00025 in.). All finished? Not by our standards. After final inspection, we cleaned every piece and packed it with meticulous care to prevent damage in transit, insuring safe and sound arrival.

Whether it's screw machine parts, forgings, castings, extrusions or impacts, Alcoa can put the metal where you want it—precisely and economically. The payoff may be fewer rejects, new flexibility in design, less waste in production, a best-selling product—or all four. To draw on Alcoa's file of ideas and Alcoa facilities, write today: Aluminum Company of America, 920-K Alcoa Building, Pittsburgh 19, Pa.

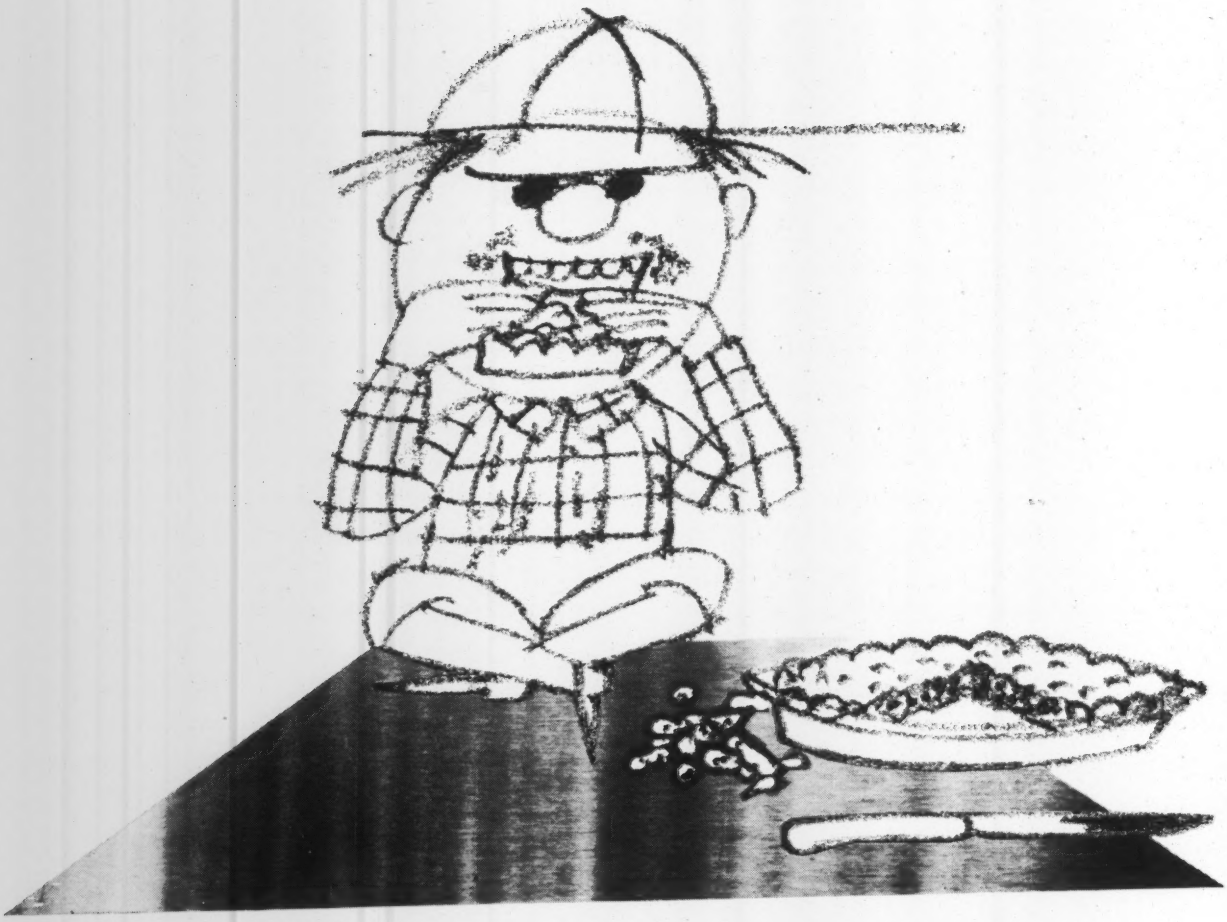
Alcoa puts the metal where you want it—in castings, forgings, impacts, extrusions and screw machine parts.

ALCOA ALUMINUM

ALUMINUM COMPANY OF AMERICA

For exciting drama watch "Alcoa Presents" every Tuesday, ABC-TV, and the Emmy Award winning "Alcoa Theatre" alternate Mondays, NBC-TV

Your Guide to the Best in Aluminum Value



STAINLESS STEEL SAYS "NO" TO STAINS!

An obvious statement, perhaps, but it pays to be obvious when you want your products to endure—*beautifully!* Stainless steel is the obvious choice, too, when you require a metal that is resistant to heat, rust, corrosion and denting, and never peels as do many plated products. No practical metal *lasts* so well, *looks* so well, as stainless steel. And Vancoram Ferro Alloys are the key ingredients in the best stainless steels made.

Producers of alloys, metals and chemicals

VANCORAM BRAND

VANADIUM CORPORATION OF AMERICA

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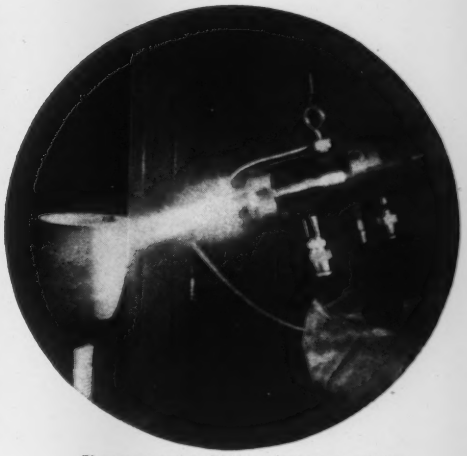
NOW— PLASMA FLAME SPRAY IN YOUR OWN PLANT



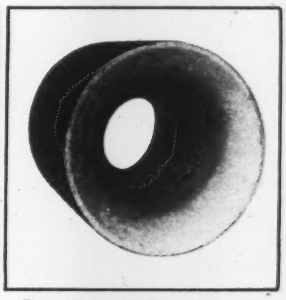
Flame spraying hi-temperature crucible

Apply coatings of high melting point materials with the METCO Plasma Flame Spray Gun...10,000°–15,000°F. A few: niobium carbide–tantalum carbide–thorium oxide–tungsten–zirconium boride

Now any material that can be melted without decomposing can be sprayed. Despite high melting temperature, object sprayed stays cool.

High fluidity of particles and high velocity of impingement bond particles together to produce high density coatings semi-fused to work surfaces. Absence of air eliminates oxidation.

Spraying tungsten on brass mandrel



Tungsten coated graphite part

Plasma Flame — how it works

The METCO Plasma Flame Spray Gun produces an arc contained in a water-cooled nozzle. An inert gas, blown through and around the arc, is "excited" to energy states having temperatures approaching 30,000°F. This Plasma "Flame" is used for melting and spraying any desired material.

Metco Type MB Plasma Flame Spray Gun

Here is a valuable new tool for the metalworking research department or production line. The METCO Plasma Flame Spray Gun operates on inexpensive inert gases, with high electrical power conversion efficiency and long component life. Continuous hot gas streams, as high as 30,000°F., with accurate control of temperature, can be generated for costs of ⅓ to ½ those of oxygen-fuel gas equipment for equivalent heat output.

Other advantages include push-button operation, extremely simple training of personnel, elimination of flash-back and explosion problems.

Materials that can be sprayed

Specifically, a wide range of metals and their oxides, carbides, borides, and refractories have been sprayed with the standard apparatus on various shaped objects and mandrels. Coating densities are easily controlled and up to 98% of theoretical can be obtained. Lowered oxide contents, with improved bond and tensile strengths are additional advantages.

The METCO Plasma Flame Gun is the latest development in flame-spraying equipment by METCO. Write today for free bulletins describing the various flame spraying processes and the Plasma Flame Spray Gun.

Metallizing Engineering Co., Inc.

METCO

Flame Spray Equipment and Supplies
Westbury, Long Island, N. Y. • Cable: METCO
Telephone: EDgewood 4-1300
In Great Britain: METALLIZING EQUIPMENT CO. LTD.
Chobham-Near-Woking, England

Metallizing Engineering Co., Inc.
1175 Prospect Ave., Westbury, L. I., New York

Please send me free bulletin on the Metco Plasma Flame Spray Gun.

Name _____ Title _____

Company _____

Address _____

City _____ Zone _____ State _____

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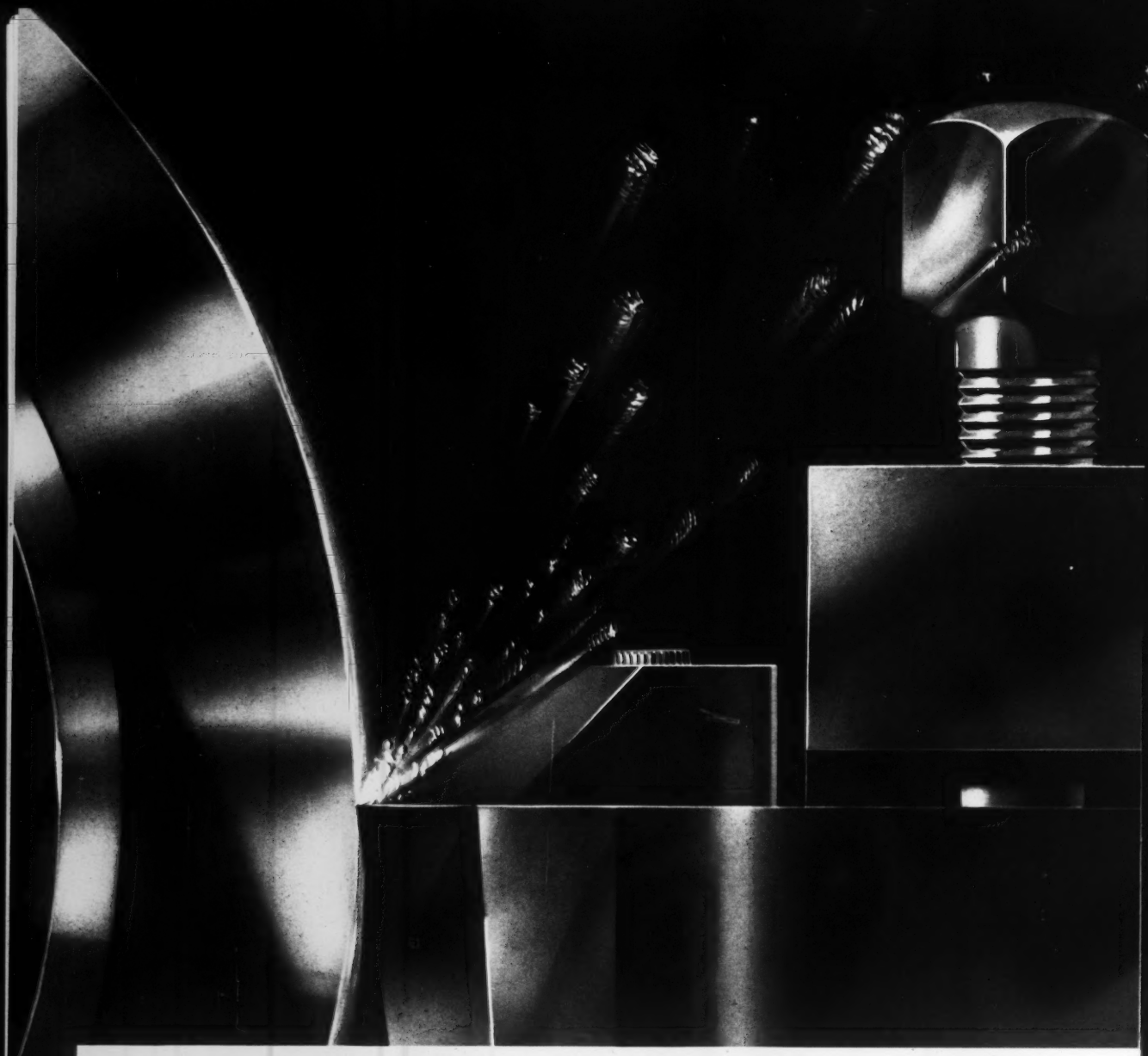


Illustration of Malleable casting being turned at 1,400 surface feet per minute with a 0.100" depth of cut using an oxide tool.

Machinability is Malleable

It's the finished cost of machined components that's important to you. Remember then . . . Malleable iron is more machinable than any other ferrous metal of similar properties. With Malleable castings you'll reduce machining time as much as 50% . . . increase tool life up to 250% . . . get unexcelled surface finishes . . . and end your reject problems.

To find out how much you can cut your costs and improve your profits, contact one of the progressive firms that displays this symbol—

If you wish, you may inquire direct to the Malleable Castings Council, Union Commerce Building, Cleveland 14, Ohio, for information.

MEMBER
MALLEABLE
CASTINGS COUNCIL

(Advertisement)

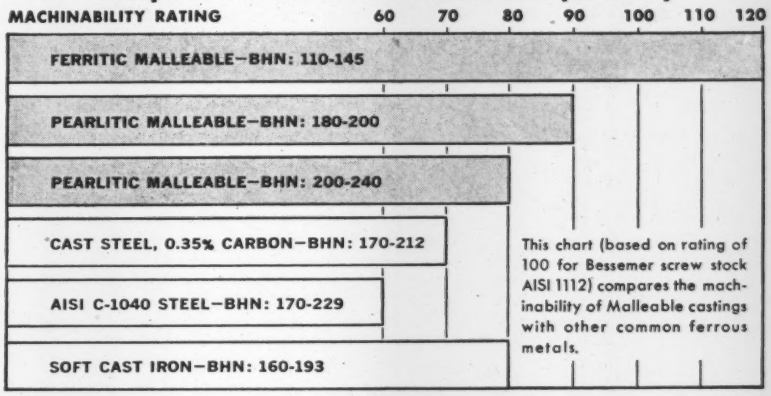
Machining Malleable Castings—Important Key to Cost Reduction

Malleable castings—the most machinable of all ferrous metals—cut quality components costs

Production men know that machining time, power consumption and rejects drop with the use of Malleable iron castings, while tool life and profits shoot up. The reason is simple: Malleable iron is the most machinable of all ferrous metals of similar properties.

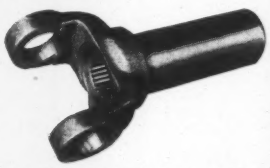
The following important factors work together to give Malleable such machining superiority: Malleable's microstructure contains tiny, evenly distributed nodules of carbon that help cutting tools quickly break the removed metal into small (Class A) chips; the carbon also acts as a lubricant, prolonging tool life; uniformity of properties throughout every casting permits running at optimum machining conditions.

Comparison Shows Malleable's Superiority



Typical Example Shows Savings of 70% to 250%

The conversion of automotive universal joint yokes from steel forgings to pearlitic Malleable castings typifies the savings provided by Malleable castings. Costs for the rough pieces and performance characteristics of the two materials are comparable. However, the castings are much more economical to machine. Considering that machining often costs two to four times as much as the rough parts, the economy resulting from using Malleable castings is substantial.



Conversion of this universal joint yoke to a Malleable casting increased production, lowered direct and tool room labor, and cut tool replacement.

One volume user of Malleable joint yokes reports the following savings after changing from steel to Malleable castings: 70% longer tool life in broaching the splines; 250% more pieces cut by the nut seat cutters; 149% more pieces in turning and facing the hub; an increase of 100% in production between wheel dressings in grinding the hub; 246% greater production in drilling the cross holes.

In each of these operations, the change to Malleable castings cuts direct production time by reducing the frequency of tool changes. Tool room labor and tool replacement are both reduced to fractions of their previous costs.

Throughout the metalworking industry, part after part is now being initially designed of Malleable or converted from other materials to take advantage of Malleable's unrivalled machinability . . . to produce better parts at lower costs.

New Information Now Available on Machining Malleable

Data Unit 106—Machinability of Malleable Castings—can be obtained from any member of the Malleable Castings Council, or from the Malleable Castings Council, Union Commerce Building, Cleveland 14, Ohio.

These companies are members of the

MALLEABLE CASTINGS COUNCIL

CONNECTICUT
Connecticut Mall. Castings Co., New Haven 6
Eastern Malleable Iron Co., Naugatuck
New Haven Malleable Iron Co., New Haven 4

DELAWARE
Eastern Malleable Iron Co., Wilmington 99

ILLINOIS
Central Fdry. Div., Gen. Motors, Danville
Chicago Malleable Castings Co., Chicago 43
Moline Malleable Iron Co., St. Charles
National Mall. and Steel Castings Co., Cicero 50
Peoria Malleable Castings Co., Peoria 1
Wagner Castings Company, Decatur

INDIANA
Link-Belt Company, Indianapolis 6
Muncie Malleable Foundry Co., Muncie
National Mall. & Steel Castings Co., Indianapolis 22
Terre Haute Mall. & Mfg. Corp., Terre Haute

MASSACHUSETTS
Belcher Malleable Iron Co., Easton

MICHIGAN
Albion Malleable Iron Co., Albion
Auto Specialties Mfg. Co., Saint Joseph
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Frazer & Jones Company Division Eastern Malleable Iron Co., Solvay
Oriskany Malleable Iron Co., Inc., Oriskany
Westmoreland Mall. Iron Co., Westmoreland

OHIO
American Malleable Castings Co., Marion
Canton Malleable Iron Co., Canton 5
Central Fdry. Div., Gen. Motors, Defiance
Dayton Mall. Iron Co., Ironton Div., Ironton
Dayton Mall. Iron Co., Ohio Mall. Div., Columbus 16
Maumee Malleable Castings Co., Toledo 5
National Mall. and Steel Castings Co., Cleveland 6

PENNSYLVANIA
Buck Iron Company, Inc., Philadelphia 22
Erie Malleable Iron Co., Erie
Lancaster Malleable Castings Co., Lancaster
Lehigh Foundries Company, Easton
Meadville Malleable Iron Co., Meadville
Pennsylvania Malleable Iron Corp., Lancaster

TEXAS
Texas Foundries, Inc., Lufkin

WEST VIRGINIA
West Virginia Mall. Iron Co., Point Pleasant

WISCONSIN
Belle City Malleable Iron Co., Racine
Chain Belt Company, Milwaukee 1
Federal Malleable Company Inc., West Allis 14
Kirsh Foundry Inc., Beaver Dam
Lakeside Malleable Castings Co., Racine
Milwaukee Malleable & Grey Iron Works, Milwaukee 46

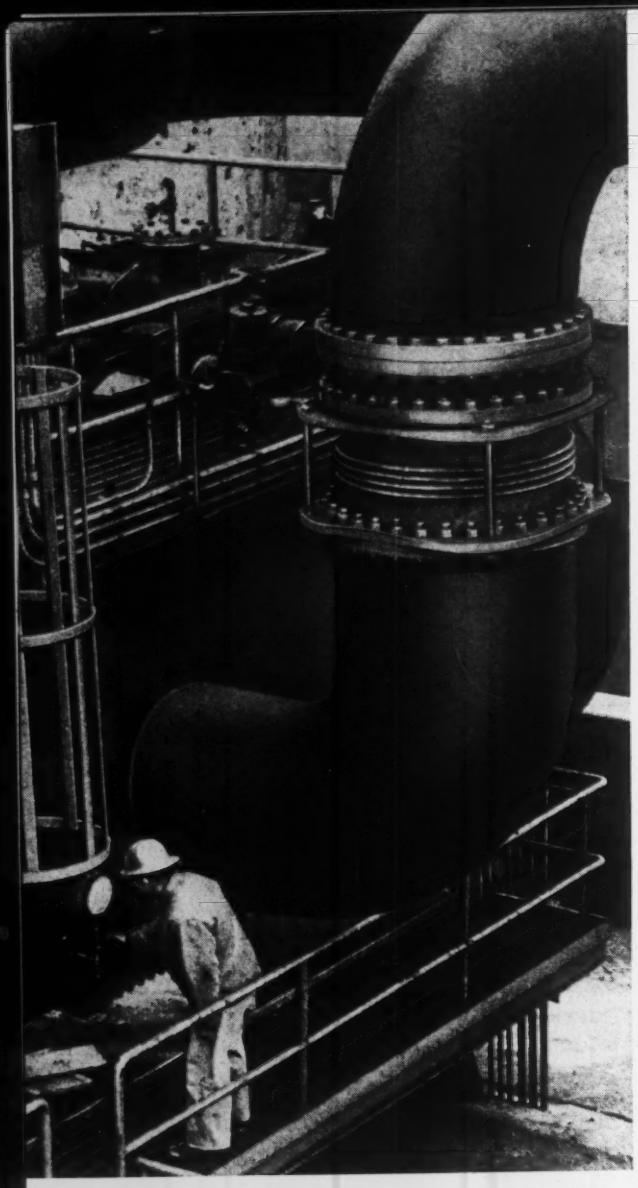
For more information, turn to Reader Service card, circle No. 395

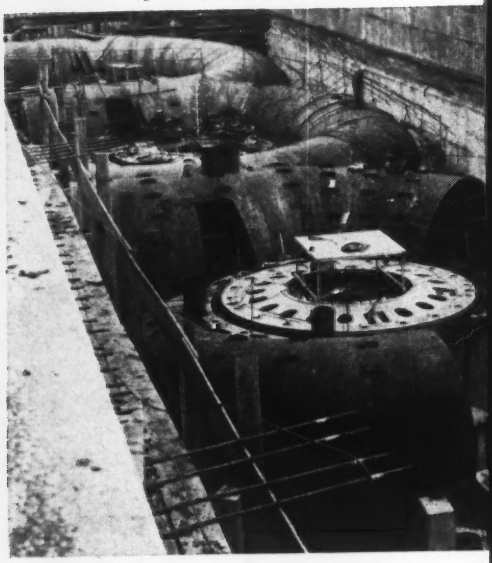
Form your own opinion A missile in flight? . . . A blacksmith's anvil? . . . The tail fin of an automobile?

STEELS FOR DESIGN

The "fin" is right—it is made of steel . . . ductile enough to stretch a point, yet strong enough to stand firm.

For some other formable examples of steel, turn the page ▷ ▷





STEELS FOR DESIGN

Stainless Steel An expansion joint in a piping system absorbs movement which might otherwise result in reduced life or even complete destruction of vital equipment and piping. One of the best types is the flexible, corrugated Stainless Steel bellows type as manufactured by Zallea Brothers of Wilmington, Delaware.

To produce these bellows, a sheet of Stainless Steel is rolled into a cylinder and welded lengthwise by special automatic equipment. This cylinder is then formed within steel dies by imposing internal hydraulic pressures as high as 4500 psi while compressing the cylinder. The smoothly shaped, cold formed bellows which results are capable of absorbing many cycles of compression, extension, rotation or lateral deflection. Because the bellows are Stainless Steel, they are corrosion resistant, maintenance-free, and capable of prolonged service under severe temperature and pressure conditions.

USS "T-1" Steel Shaped like a giant seashell, a turbine scroll case must withstand tremendous pressure. Water gushes through the conch in an ever-tightening spiral before shooting into the blades. Chicago Bridge & Iron Company used USS "T-1" Constructional Alloy Steel for the shells of four of the largest scroll cases in the Noxon Rapids Dam in Montana. Because of the exceptional strength of "T-1" Steel—115,000 psi minimum tensile strength—the walls could be made nearly 50% thinner and 50% lighter than carbon steel walls. Freight costs were lower. And because there was considerably less weight, the foundations for the cases could be made lighter and less expensive.

USS MAN-TEN High-Strength Steel Manufacturers have turned to high-strength steels to increase the strength of earthmovers without adding to their weight. LeTourneau-Westinghouse Company built their Model B scraper with USS MAN-TEN Low-Alloy High-Strength Steel in the yoke structure, side sheets, body truss tubes, and apron arms. MAN-TEN steel has a yield point of 50,000 psi—about 50% higher than carbon steel. This extra strength also permits designs with thinner, lighter sections that can reduce weight as much as 1/3 with no loss of strength. And though MAN-TEN steel is exceptionally strong, it is not difficult to form. In fact, MAN-TEN steel frequently simplifies fabrication because it can be used in lighter gages.

USS, MAN-TEN, and "T-1" are registered trademarks

United States Steel USS

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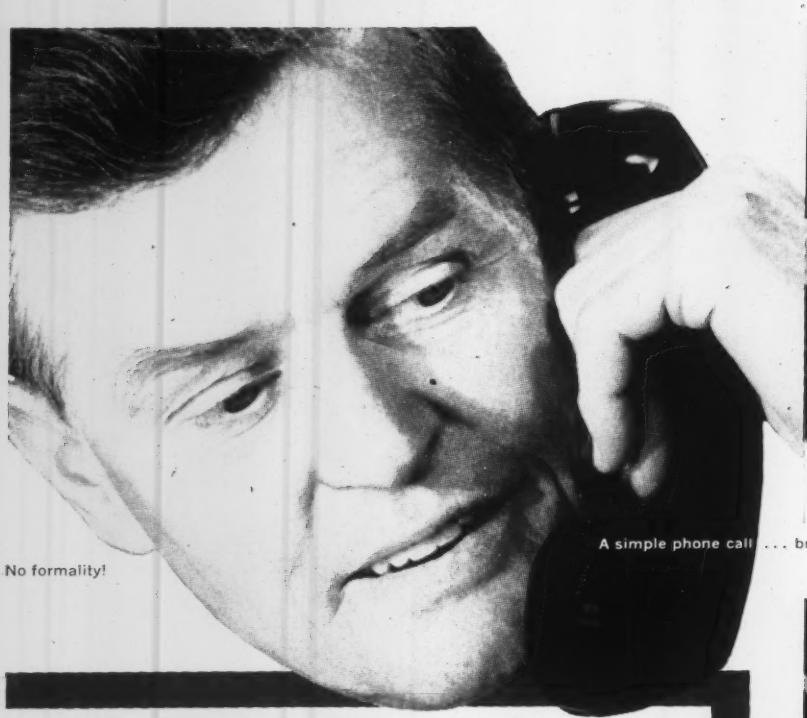

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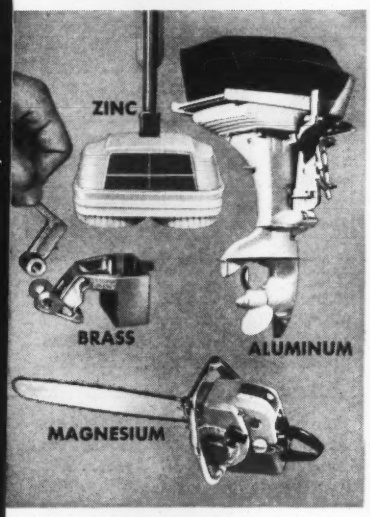

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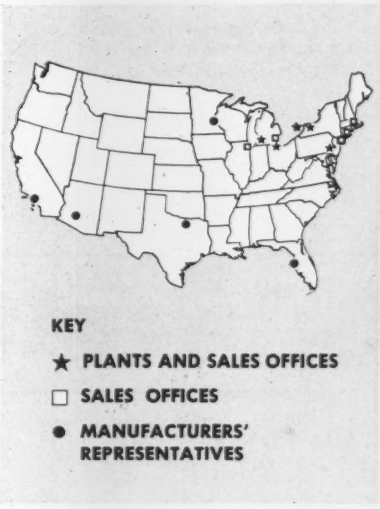

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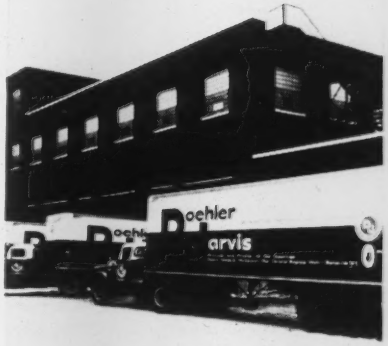

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In addition to austenitic manganese steel castings—long known for their exceptional service life in mining, construction, quarrying and milling applications—Amsco now offers *seven* other ferrous alloy materials. These include specially alloyed manganese steels, chrome moly steels, high strength alloyed steels and alloyed cast irons.

Each has particular advantages for specific service requirements, involving various combinations of impact, stress and wear. Check the brief facts on these alloys below. Then call in an Amsco sales engineer to assist in selecting the *one best* material to meet your application needs.

AMSCO ALLOY DESIGNATION	DESCRIPTION AND USES	MECHANICAL PROPERTIES
MY	Heat-treated, chromium alloyed manganese steel... for use in light-to-medium weight castings requiring modest improvement in growth and distortion, and increased stiffness.	tensile strength ..... 120,000 psi yield strength ..... 56,000 psi elongation ..... 45% reduction of area 30%
MML	Heat-treated, molybdenum alloyed manganese steel... for castings requiring improved weldability, for extremely heavy metal sections, and castings exposed to excessive heating environments.	tensile strength ..... 120,000 psi yield strength ..... 52,000 psi elongation ..... 50% reduction of area 40%
MMH	Heat-treated, molybdenum alloyed manganese steel... for use in castings requiring optimum mechanical properties and wear resistance. Provides improved stiffness and resistance to peening and flow.	tensile strength ..... 120,000 psi yield strength ..... 65,000 psi elongation ..... 20% reduction of area 18%
CML	Heat-treated, air-hardening chrome-moly steel... for casting applications involving scouring or grinding wear. Suitable for more complex casting designs.	tensile strength ..... 155,000 psi yield strength ..... 130,000 psi elongation ..... 10% reduction of area ..... 15% hardness ..... 275-375 BHN
CMH	Heat-treated, air-hardening chrome-moly steel... exhibits potentially improved wear resistance over CML (above), when shock loading is not sufficiently severe to cause breakage.	tensile strength ..... 155,000 psi yield strength ..... 130,000 psi elongation ..... 6% reduction of area ..... 7% hardness ..... 300-400 BHN
CS	Martensitic, multiple alloy steel with chromium, nickel and molybdenum... combines high mechanical strength with good abrasion and wear resistance.	tensile strength ..... 220,000 psi yield strength ..... 195,000 psi elongation ..... 8% reduction of area ..... 20% hardness ..... 300-500 BHN
HC	High chromium cast iron... provides outstanding abrasive wear resistance, where impact force is low but particle velocity and scouring forces are high.	tensile strength ..... 60,000 psi transverse strength ..... 7,000 lbs. deflection ..... 0.12 in. hardness ..... 400-600 BHN

For further information
—write for technical bulletin on "Amsco Ferrous Alloy Castings".

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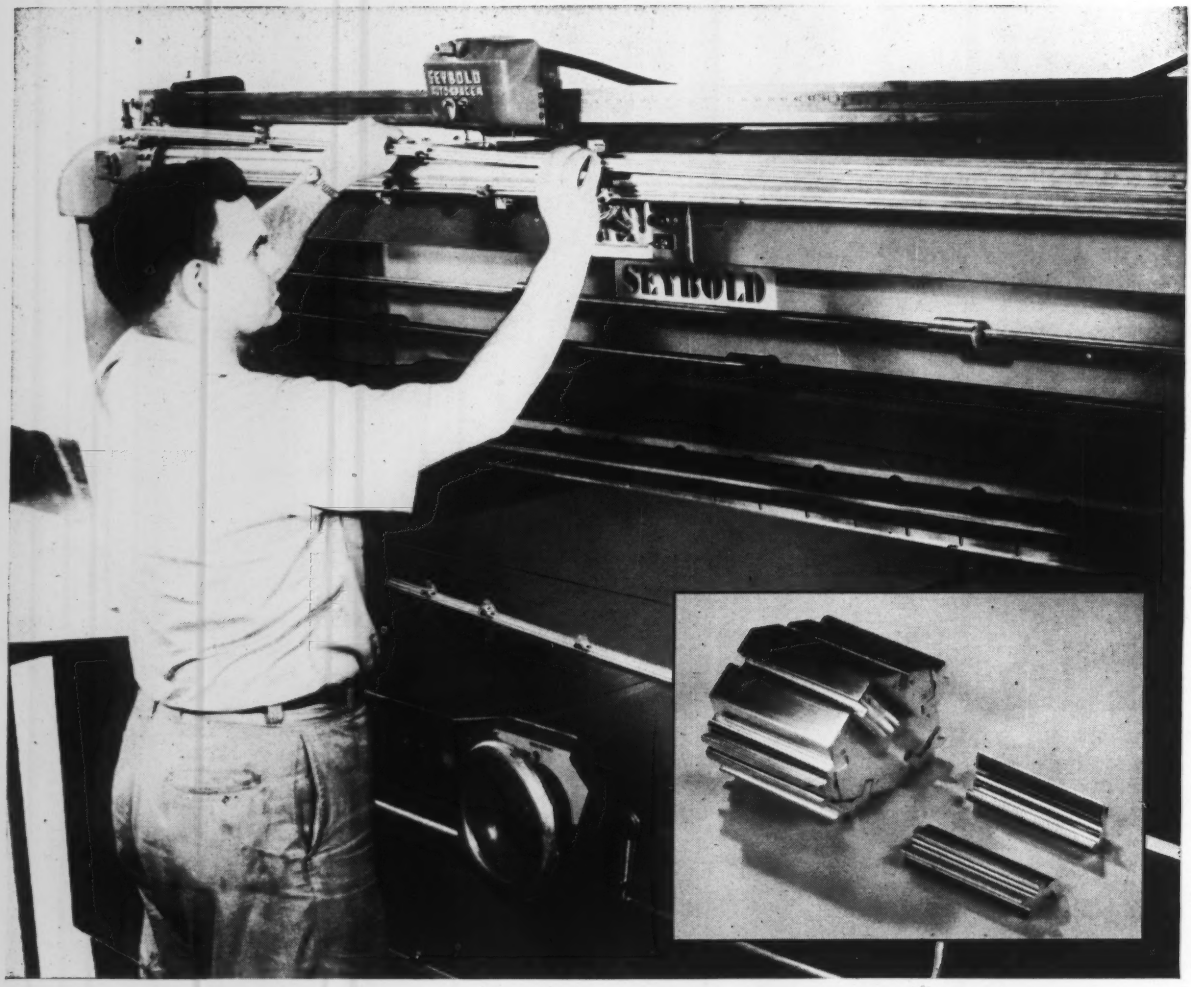
DOW | METAL PRODUCTS



PRECISION MAGNESIUM EXTRUSIONS (inset) form two key parts for hydraulic paper cutter.

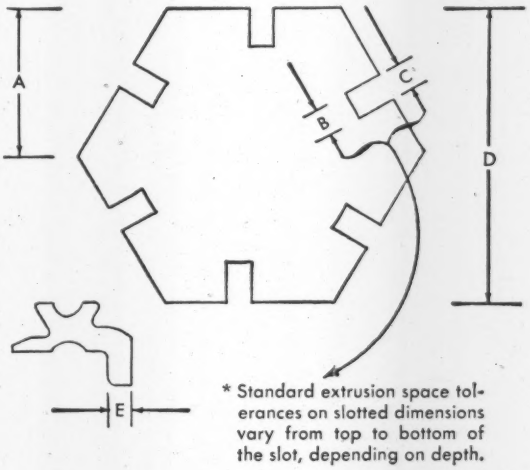
PRECISION EXTRUSIONS

tighten tolerances, cut costs

Paper cutter manufacturer slices production costs by replacing all-milled components with magnesium precision extrusions boasting tolerances as close as ± 0.0025.

Precision magnesium extrusions—a recent development of Dow's Madison, Illinois plant, deliver a big assist in the design of parts that must be extremely accurate and dimensionally stable. A wide variety of precision parts can be extruded with substantial savings in scrap loss, machining and setup time.

Harris-Seybold Company, a division of Harris Intertype Corporation, puts these advantages to work in the manufacture of hydraulic paper cutting machines. Results: six different machining and allied operations eliminated . . . machining and setup time for two key parts reduced by 64% and



* Standard extrusion space tolerances on slotted dimensions vary from top to bottom of the slot, depending on depth.

TOLERANCES HELD ON PRECISION MAGNESIUM EXTRUSIONS

Critical Dimension	Standard Extrusion Tolerance	Precision Extrusion Tolerance
A	± 0.012	± 0.0025
B*	± 0.007	+ 0.003 − 0.000
C*	± 0.012	+ 0.003 − 0.000
D	± 0.024	± 0.005
E	± 0.007	+ 0.000 − 0.003

78%. Basic material costs were also lowered. The metal previously used was supplied in a high-property alloy in order to minimize warpage during the extensive machining operations. The standard magnesium alloy now used costs less. In addition, straightening operations required with the previous metal are no longer necessary.

The two parts Harris-Seybold now buys as precision magnesium extrusions serve to position the paper correctly for a number of successive cuts. They range from 46 to 106 inches in length and must be both dimensionally accurate and free of kinks and bows. No machining of these extruded parts is required after they are received in the Harris-Seybold plant.

For facts and figures about precision magnesium extrusions as they apply to your requirements, write to THE DOW METAL PRODUCTS COMPANY, Midland, Michigan, Sales Department 1341CD12.

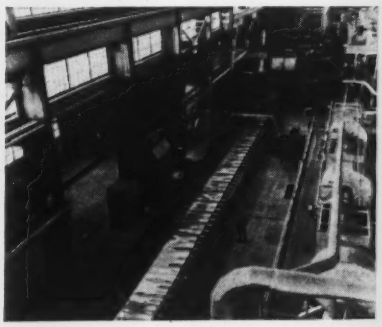
HOW MAGNESIUM PRECISION EXTRUSIONS CUT SETUP AND MACHINING TIME

PART AND MATERIAL	OPERATIONS REQUIRED	TOTAL SETUP & MACHINING TIME
Spacer Bar:		*10 pieces per production run*
Previous Metal	8	1,750 minutes
Magnesium Precision Extrusion	5	626 minutes
Stop Carrier Strip:		*60 pieces per production run*
Previous Metal	8	2,399 minutes
Magnesium Precision Extrusion	5	510 minutes

OPERATIONS ELIMINATED BY MAGNESIUM PRECISION EXTRUSIONS

Spacer Bar	Stop Carrier Strip
1. Straightening	1. Straightening
2. Milling slots	2. Milling critical dimension
3. Burring slots	3. Straightening

GIANT EXTRUSION PRESS, largest used to extrude magnesium, produces sections up to 30-inch circumscribed circle. This 13,200 ton press extrudes large structural shapes of magnesium and aluminum for aircraft and missile parts, other applications.



ROLLING MILL at Madison, Illinois is the largest in the world for magnesium alloys. Flat sheet and plate and coiled sheet are produced in a wide range of sizes. Extra flat tooling plate for all tooling uses is also produced at this plant.

THE DOW METAL PRODUCTS COMPANY, Midland, Michigan

A Division of The Dow Chemical Company

For more information, turn to Reader Service card, circle No. 377

Steel and aluminum users report increased values from Ryerson

These case histories—selected at random from our files, provide additional evidence that you consistently get increased value for your purchasing dollar from Ryerson. Individual points of difference between Ryerson and other sources may not by themselves seem overwhelming—but in total they add up to an important difference in dependability, experience and capacity to serve.

A world famous manufacturer formerly tested all steel purchased from steel-service centers for critical ordnance work. But, often, test costs on small lots of steel were greater than material costs. So the company decided to concentrate its purchases with sources proved completely reliable—and discontinue its own testing. Experience showed that the required certifications of quality were always absolutely dependable in the case of only three steel suppliers—among them Ryerson where quality has been a watchword since 1842.

Milling operation eliminated. A structural fabricator followed the usual practice of milling the ends of beams to be used as column bases until he discovered the accuracy and squareness of Ryerson friction sawing. Now he has eliminated the milling operation because, at no extra cost, Ryerson can guarantee friction saw accuracy of only ± 1/16″ for beams up to 6″ and ± 1/8″ for sections over 6″—squareness tolerances of .010″ per inch of section.

Better product appearance and a worthwhile saving in material cost resulted when a Ryerson man recommended that a producer of portable coolers switch from one aluminum alloy (3003-H14) to another (5005-H14). Slightly higher structural strength was a bonus value. Unusually broad aluminum stocks and technical resources often enable Ryerson to serve in this way.

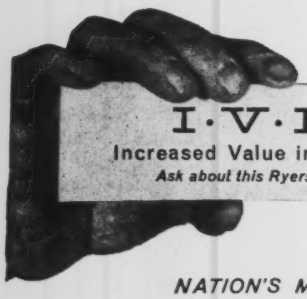
The need was urgent. A breakdown was cutting output of a big paint producer, and the steel needed to repair the break was not available in the area. However, the required analyses and size *was* on hand at the nearest Ryerson plant 200 miles away—and within an hour Ryerson delivered 100′ of this bar stock to the local airport. Three and a half hours after calling Ryerson in another state, the customer had his steel.

"Deeper cut, better finish, longer tool life, and lower total per-piece cost." These were the results reported by a Mass. machining company after it switched to Ryerson Rycut® 40 alloy steel for shafts, gears and spindles used in rugged machine tools. Ryerson Rycut steels are the world's fastest machining in their carbon ranges.

Missile component problem solved. Titanium stringers in stainless forged bars were creating a high reject rate for a missile parts manufacturer. His Ryerson specialist recommended a switch from Type 321 stainless to Type 347. Results: the same stabilized corrosion-resistance and strength—but no titanium stringers.

Furniture manufacturer saves 15¢ per unit on every chair produced. A *rolled* aluminum angle was being used where strength was not an important factor. A Ryerson aluminum specialist suggested an *extruded* angle which gave all the strength needed in the application, was more easily formed, had better appearance—and reduced costs as well.

These are just a few examples that illustrate the advantages that make Ryerson service truly unique. A call to your Ryerson representative may solve similar problems for you.



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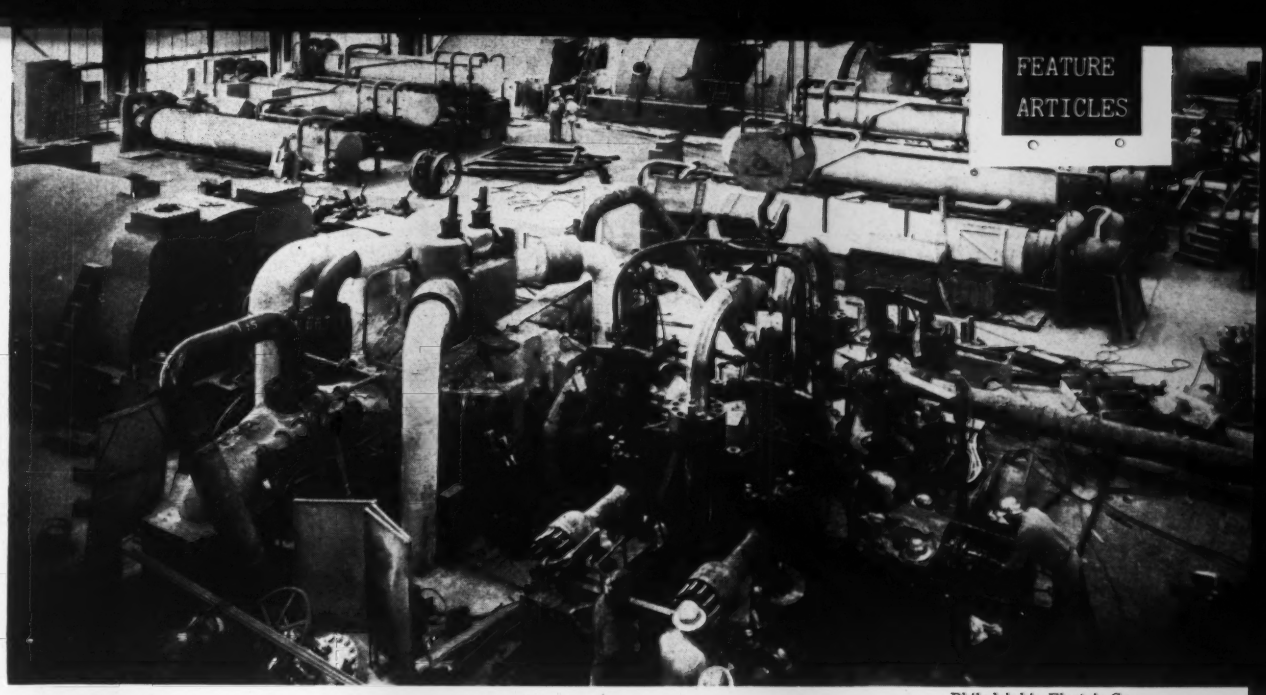


Philadelphia Electric Co.

Turbo-generator *and control system in last stages of assembly at Eddystone plant.*

Philadelphia Electric's new Eddystone plant will run at the highest temperature and pressure ever used in a steam power plant—a fact which made necessary many departures from conventional materials practice. Here is how engineers and metallurgists met the challenge with . . .

Materials for 1200 F / 5000 Psi

by Robert J. Fabian, *Associate Editor, Materials in Design Engineering*

■ The continuous quest to raise the efficiency and lower the operating costs of steam power plants has produced a steady increase in operating temperatures and pressures. Each rise in temperature and pressure has created a new challenge in materials selection. But at no time has the challenge been greater than in the design of the new Eddystone No. 1 power plant now undergoing initial tests by the Philadelphia Electric Co. This new 325,000-kw power plant is designed to operate at 5000 psi and 1200 F—the highest pressure and temperature yet used in a steam power plant (about 500 psi and 50 °F higher than the 120,000-kw Philo Station, which is the latest comparative supercritical power plant put into operation).

The widespread use of austenitic stainless steels in Eddystone is a significant departure in materials selection for steam power plants. Austenitic alloys have been used in many power plants before, but never in such large quantities and under such severe conditions. The austenitic alloys were necessary because none of the conventional ferritic materials would do the job.

Naturally, austenitic alloys are expensive when used in such large quantities (hence the newly-coined expression "austenitic barrier"). But the designers of Eddystone hope that the higher efficiencies resulting from their use will, in the long run, more than make up for high initial cost. If the power plant comes up to predictions it will have the highest thermal efficiency yet achieved in power plants. However, even if predictions are not met, the experience gained with new materials and design concepts will be important in advancing the art of steam power plant design. Thus, Eddystone will have a strong influence on the power plant of tomorrow.

Superpressure turbine materials

- *First use of Discaloy for steam turbine rotor*
- *Superalloy blades run 125 °F higher than before*
- *Inner turbine casting one of largest ever made*
- *Unique transition section joins dissimilar metals*

The turbine section of the Eddystone plant, designed and manufactured by the Steam Div. of Westinghouse Electric Corp., is divided into several units, each handling steam at a different pressure. In order of decreasing pressure these separate turbines are called: superpressure, very high pressure, high pressure, intermediate pressure and low pressure turbines. An important advantage of dividing the turbines up in this way is that unusually high temperatures and pressures can be confined to the superpressure turbine (Fig 1). Once the steam leaves the superpressure turbine it is at conventional pressures and temperatures and can be handled in turbines of more-or-less conventional design. Thus, unusual materials selection problems are encountered only in the superpressure turbine.

First use of Discaloy

The most important factors considered in selecting the superpressure rotor material were:

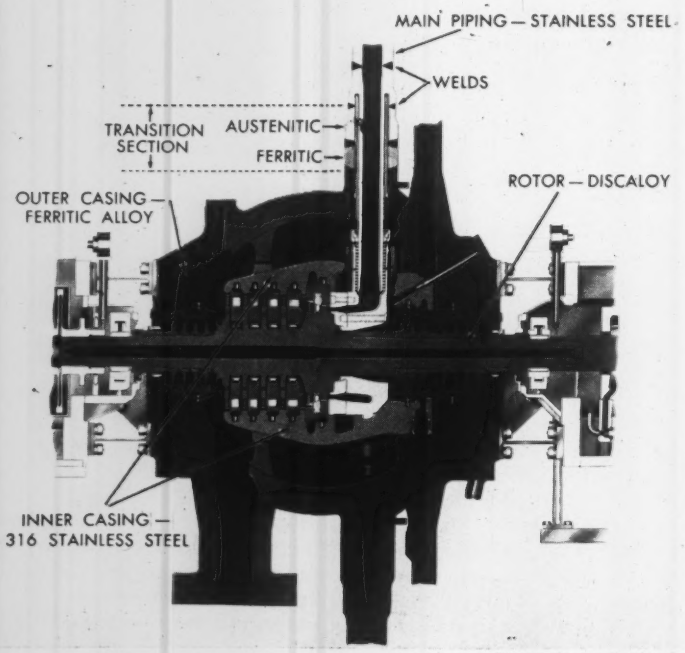
1. Adequate strength at room temperature.
2. Good strength and stability at the maximum operating temperature of 1200 F.
3. Optimum thermal expansion characteristics.
4. Material availability.
5. Manufacturing and service experience.

The alloy with the best balance of properties to meet these requirements proved to be Discaloy —an iron-base superalloy typically containing 26% nickel and 13.5% chromium, hardened with 2.25% molybdenum and 1.7% titanium, and having additions of manganese, silicon, aluminum and carbon. Discaloy had previously been used successfully in gas turbine engines but this was its first use in steam turbines. By altering composition and heat treatment, the alloy can be designed for short life–high stress applications (i.e., gas turbines) or long life–low stress applications (i.e., steam turbines).

Forging closely checked—The ingot for the rotor forging was one of the largest ever produced in Discaloy—about 15,500 lb. After forging to required shape the rotor weighed a little over 3000 lb. Its dimensions after final machining are roughly 11 ft long, 2 ft max dia.

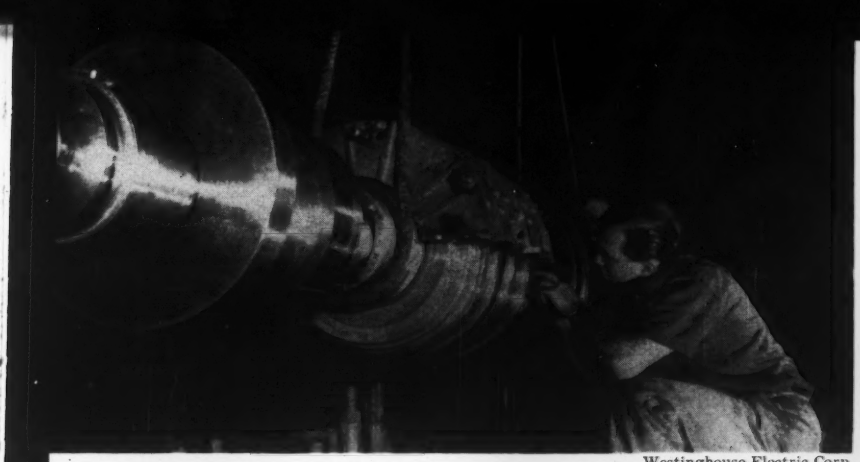
Rigid procedures were followed in heat treating, processing and testing the alloy forging. A close forging schedule was followed to control grain size and to obtain as fine a grain as possible. Creep-rupture and short-time tensile tests were made on sections cut from between the rotor disks. Additional tests were made on material cut from the forging ends and, as a further check, creep-rupture tests were made on sections cut from the very center of the forging. The forging itself was given a series of nondestructive fluorescent penetrant tests and ultrasonic tests, the latter proving more useful than radiography in inspecting such a large forging.

Thermal stability a problem— It is important that the superpressure rotor be dimensionally stable at the expected operating temperatures and speeds. Continuous checks had to be made on the rotor's thermal stability during the various manufacturing stages. These checks started with the



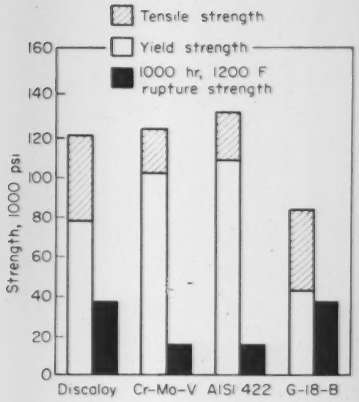
Westinghouse Electric Corp.

1 ***Superpressure turbine*** *requires special materials to handle steam at 5000 psi and 1200 F. Other turbines in system handle steam at conventional pressures and temperatures and can use conventional materials.*

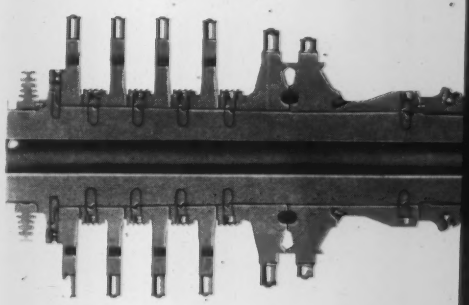


Westinghouse Electric Corp.

2 ***Integral disk rotor*** *for superpressure turbine is made of Discaloy, an alloy originally developed for gas turbine engines.*



3 ***Comparative properties*** *of Discaloy and three other superpressure rotor alloys.* (Westinghouse Electric Corp.)



Westinghouse Electric Corp.

4 ***Disk-type rotor*** *can use a small diameter shaft because rotor disks are shrunk on and are not an integral part of rotor shaft.*

rough machined forging which was given slow-roll thermal stability tests right at the forging plant. Next, the forging was machined so as to simulate the expected configuration of the final bladed rotor. In this configuration the rotor was operated at temperatures and speeds higher than the expected operating conditions for more than 250 hr. Finally, the rotor was machined to final shape (see Fig 2), bladed, and run at standard temperatures and at standard speeds and overspeeds.

Alternate rotors made — Since the choice of Discaloy was unconventional, special precautions were taken to allow for any unexpected malfunctions. Two integral-disk rotor forgings and one separate-disk rotor were made as alternate, backup rotors for the Discaloy integral-disk rotor.

The two integral-disk rotors were made of 442 stainless steel and a Jessup G-18-B alloy. The G-18-B alloy is a 13 chromium-13 nickel-10% cobalt alloy with additions of molybdenum, cobalt, tantalum and tungsten, and has been used for steam turbine rotors in Europe. From Fig 3 it is obvious that these alloys are not as strong as Discaloy and would be suitable only for limited operation. Although G-18-B has creep and rupture strengths comparable to those of Discaloy, it has relatively low yield strength at room temperature. Fortunately, since the Discaloy rotor has successfully passed all tests it does not appear that any of these backup rotors will have to be used.

The separate-disk backup rotor mentioned above is an unusual departure in rotor design. This rotor (Fig 4) differs from the others in that the turbine blades are carried by disks which are shrunk on the shaft. Thus, the rotor shaft can have a considerably smaller diameter than that required for integral-disk rotors. The separate disk rotor (it is also made of Discaloy) was made not only as an alternate rotor, but to obtain experience in this unique type of construction. If the design proves feasible in shop testing it can pave the way for future high temperature, lightweight rotors.

Blades withstand 1200 F

The blading for the superpressure turbine consists of six rows of blades. The blades in the first four rows where the highest temperatures are encountered are machined from K-42-B alloy. The last two rows are made of 422 stainless steel—a conventional blading material.

The K-42-B material is a standard Westinghouse superalloy with a nominal composition of 42% nickel, 22% cobalt and 18% chromium. It was originally developed for gas turbine blades. Although the alloy has been used at 1200 F in gas turbines, it had never been used above 1075 F in steam turbines. On the basis of its excellent performance in gas turbines, however, Westinghouse engineers expect it to perform as well in the 1200 F superpressure turbine.

Inner castings weigh 8550 lb

The two inner turbine castings (see Fig 1) used in the Eddystone superpressure turbine are among the largest pressure vessel castings ever made. They average 8550 lb each.

The material used is a modified 316 stainless steel casting alloy of slightly different composition than the chromium-nickel alloys ordinarily used for high temperature turbines. Chromium and molybdenum content of the alloy were kept on the low side and nickel content on the high side. Although this particular composition may have reduced the aver-

age strength of the alloy, it is expected to considerably improve the alloy's resistance to embrittlement and thus insure long life at high temperatures.

Because of the critical pressures and temperatures involved, the castings were given a rigorous series of nondestructive tests. Radiography, magnetic particle, and fluorescent penetrant tests were extensively used to detect flaws.

Transition section welded

A tricky joining problem was encountered in joining the 316 stainless steel main piping to the ferritic (2¼% chromium, 1% molybdenum, ¼% vanadium) outer casting of the turbine. It is very difficult to weld dissimilar metals of such large section in the field. However, as shown in Fig 1, this problem was solved by using an extra series of welds and a short transition section. The upper half of the transition section is made of an austenitic alloy similar to the main steam piping, and the lower section is made of a ferritic material similar to the outer casting. The transition section can be easily handled and welded under controlled conditions in the shop. In addition, it can be readily shop tested with techniques and equipment that would be difficult to use under field conditions.

Steam generator materials

- *New tube alloy stressed 50 to 100% higher than next best alloy*
- *Largest amount of 316 stainless yet used in steam generator*
- *G-18-B superalloy meets tough valve requirements*

In addition to its advanced design features, the Eddystone steam generator or boiler is distinguished for its unusual use of tube materials (Fig 5). Many of the conventional ferritic materials had to be by-passed in favor of austenitic stainless steels having higher strength at high temperatures. And a special new material had to be developed for the finishing superheater—the section where the highest pressures and temperatures are encountered.

New tube alloy developed

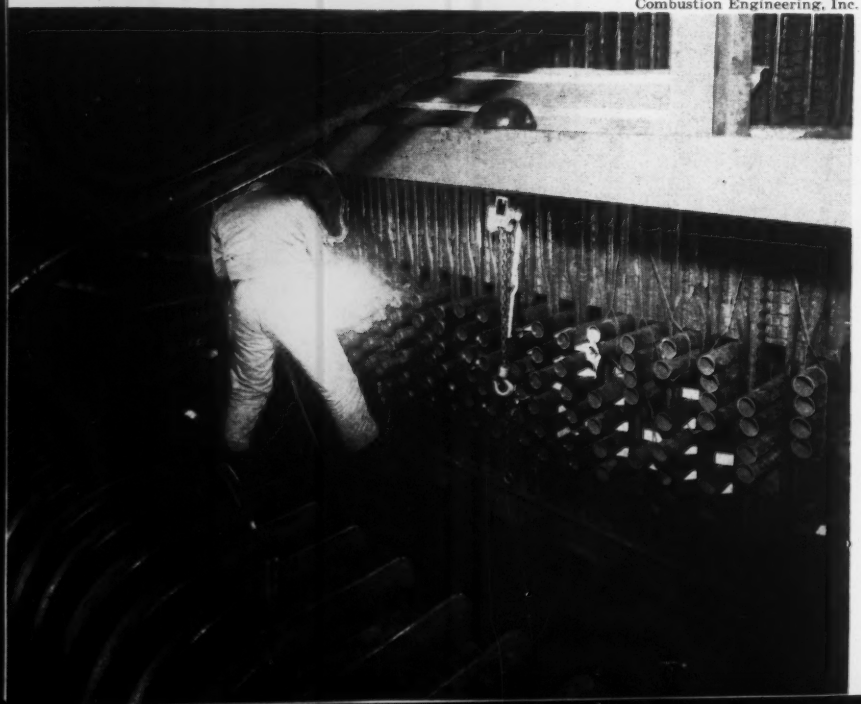
Some experience has been gained with 316 stainless steel in the finishing sections of steam generators. However, investigations showed that this material would have to be used in impractical wall thicknesses to handle the 1250 to 1350 F temperatures (outside tube temperatures) and 5000 psi pressure in the finishing superheater.

Consequently, designers looked outside of the accepted ASME Boiler Code materials and selected a new high strength, high temperature alloy composed of 17% chromium, 14% nickel, 3% copper and 3% molybdenum. This alloy—familiarly called 17-14-copper-moly—was thoroughly investigated to establish its fabrication characteristics and high temperature strength. Stress-rupture tests both on the conventional strip form and on closed-end tubular specimens under internal pressure were run by Combustion Engineering, Inc. Tube production problems were solved by the Steel and Tube Div. of Timken Roller Bearing Co. Special approval for use of this new material was granted by the Industrial Board of the Pennsylvania Dept. of Labor and Industry.

The new alloy has allowable stresses which are 50 to 100% higher than those of 316 stainless steel in the 1250 to 1350 F temperature range. Thus, considerably thinner walls can be used. Although

5 ***Boiler tubes*** *are made of many different alloys, depending on their location. Special 17-14-copper-moly alloy was developed especially for finishing superheater. Type 316 stainless was required for upper part of boiler.*

Combustion Engineering, Inc.



the new alloy costs about 30% more than 316 stainless, the thinner walls bring its cost per foot down to about the same as for 316.

Fabricating difficulties were encountered with the 17-14-coppermoly alloy because it was extremely difficult to pierce and form into pipe. However, continued research by Timken resulted in a suitable fabricating technique, details of which have not yet been disclosed.

Heat treatment at very high temperatures—2150 F and above—is needed to develop the high temperature properties of the alloy. Conventional austenitic steels are usually heat treated at a little over 2000 F.

Broad use of 316 stainless

Apart from the finishing superheater, the steam generator is made of conventional, previously used tube materials. However, the design is noteworthy for its use of large quantities of austenitic stainless steels. Types 316 and 321 were used for the upper half of the two boilers—type 316 in the higher temperature areas and type 321 in the lower temperature areas. Other lower strength alloys could have been used in the upper boiler section. However, they would have had to be used in excessive wall thicknesses which would reduce heat transfer and create high thermal stresses between inner and outer surfaces.

The austenitic pipe materials created a problem because of their relatively high thermal expansion. The supports are located outside the boiler pipes and for balancing purposes should have the same expansion characteristics as the boiler pipes. Since austenitic pipe would expand about 35% more than its ferritic supports, austenitic supports had to be used despite their higher expense.

Valve materials chosen carefully

The valves used in the Eddystone system (a monotube design) differ from conventional designs and required careful materials selection because of the high temperatures and high pressures. The valves are designed to shut the steam off between the boiler and the turbine, and they also allow steam to be by-passed around the turbine. Their design was worked out in a cooperative effort by Combustion Engineering and Sulzer Bros., Ltd. of Switzerland.

After a full study of many available materials, designers chose the Jessup G-18-B alloy for the main pressure-containing body of the valve. This alloy is the same as the one used for the backup turbine rotor described earlier. It had previously been used for other demanding applications such as aircraft gas turbines. However, until Eddystone there had never been a need for such a high strength, high temperature material for steam generator valves.

The G-18-B alloy created a special problem in that new welding techniques had to be developed to join the valve body to the 316 stainless steel main piping. After many welding studies, it was decided to weld 316 stubs to the G-18-B body in the shop under controlled conditions, thus avoiding field welding of dissimilar metals. The 316 stubs could be welded with relative ease to the 316 main piping in the field.

Main piping materials

- *First use of austenitic pipe materials at 1200 F*
- *Rigid checks required during forging, heating, bending, welding*
- *Special welding methods assured complete penetration of joint*
- *Accelerated life tests will run concurrent with actual service*

The main steam piping is the piping that runs from the finishing superheater of the boiler to the turbine inlet. Ferritic steels have had an excellent record in steam piping at temperatures to 1050 F. However, they do not have sufficient oxidation resistance and strength to meet current high temperatures and pressures.

First large use of 316 stainless

Of the many alloys considered for the Eddystone main steam piping, five were selected for intensive study: 316 and 347 stainless steel, a 17 chromium–14 nickel–3 copper–3% molybdenum alloy similar to the finishing superheater alloy mentioned above, 15–15N, and the G-18-B alloy. After intensive research 316 stainless was selected. This alloy is an accepted ASME Boiler Code material and has previously been used for main steam piping. But never at 1200 F and never in such large quantities. (The 2400 ft of 316 stainless main piping used in Eddystone are divided into 56 fabricated assemblies, up to 50 ft long, and weighing from 4 to 5 tons each.)

Pipe bending critical

Because of the unusual conditions that had to be met, every detail of pipe manufacture—from initial pouring of the metal to final welding—had to be closely controlled by the pipe supplier, M. W. Kellogg Co. Many specifications were prepared to assure that the material had the desired chemical, physical and mechanical properties. In addition to ladle analysis, tests were made on

specific pipe sections from each heat of steel. Complete records were kept on the history of ingots from each heat and on the pipe sections from each ingot.

The pipe was produced by double forging billets to approximate size, then turning and boring. The pipe is the largest 316 pipe yet fabricated, ranging from a 4-in. i.d. and 2.4-in. wall to a 4.9-in. i.d. and a 2.9-in. wall. Extreme care was taken during fabrication. Temperature specifications were required during hot bending to prevent overheating. During heating operations the pipe sections were purged with an inert gas to minimize internal surface oxidation.

After bending (Fig 6), the pipe assemblies were solution heat treated to relieve internal stresses. As an added precaution, all assemblies and bends were given a liquid penetrant inspection to detect surface flaws and an ultrasonic test to check on internal soundness.

Gas pressure shaped weld contours

All welds in the main steam piping were made by a special welding method developed by Kellogg (Fig 7). This method has been used to weld main steam piping before and is an outgrowth of the company's experience in welding thin-walled rocket tubes.

Key advantage of the welding method is that it assures complete penetration without backing rings. Dams are inserted within the pipe on both sides of the weld. The dams prevent the escape of an inert gas which is forced into the pipe under controlled pressure to shape the inner contour of the first bead and prevent oxidation. Inert gas-shielded arc welding is used to apply the root bead to the joint. By controlling the gas pressure inside the pipe, it is possible to deposit the inner surface of the bead with a highly uniform, flush contour. As welding progresses, the increasing weight of the weld puddle is supported by increasing the gas pressure.

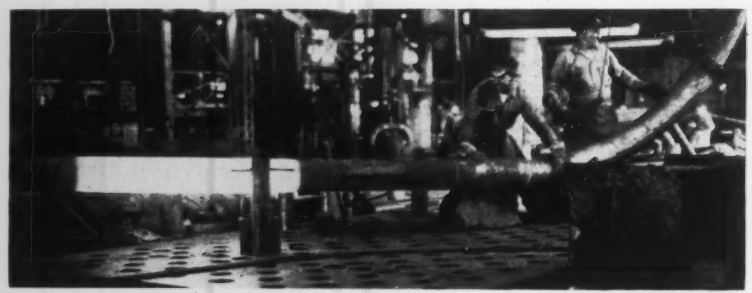
Each weld base layer was inspected with dye penetrants. After inspection, weldout or filling of the 3-in. V-groove was completed by the manual arc method using 16 chromium–8 nickel–2% molybdenum steel electrodes.

Accelerated tests check pipe life

When using any material under new conditions there is always the possibility that something will show up during operation which preliminary tests had failed to reveal or predict. To play it safe, therefore, the pipe designers plan to run an accelerated life test on 316 main pipe material at the same time that the actual pipe is in operation. By running the test pipe continuously at 1225 F instead of the normal 1200 F any changes may be expected to be accelerated by a factor of about 2½. Thus, if anything unusual occurs (particularly in welded joints) it will occur first in the test pipe—and far enough in advance to permit inspection of the actual main pipe.

The special test is also used to check the mechanical properties of welded joints. Several segments of welded pipe have been placed loosely in the test pipe. Each time the test pipe is shut down for inspection, two of these welded segments are removed (in all there are about 16 segments in the pipe) and given a complete visual inspection and set of mechanical tests to see how they are behaving.

Aside from the higher temperature used, the test pipe is operated at the same internal pressure as the main steam pipe and is externally loaded to simulate the weight and expansion loads on the main pipe. Pressures higher than the expected 5000 psi are not used, as the effect of overstressing on accelerated life can not be determined.

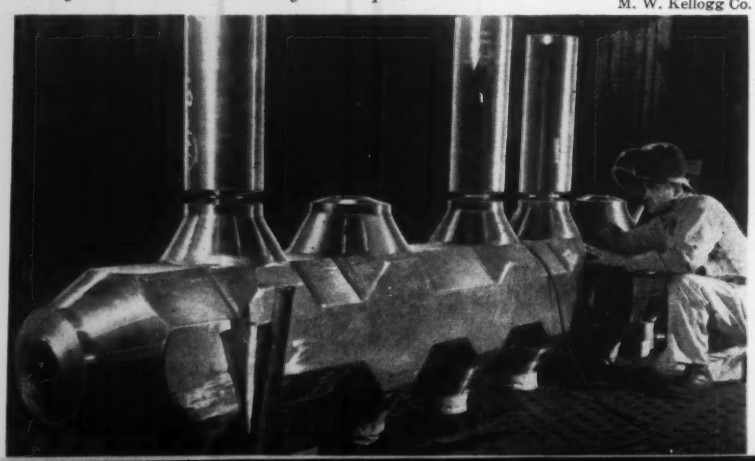


M. W. Kellogg Co.

6 ***Main steam piping*** *being prepared for hot bending.*

7 ***Integral header*** *weighing 10 tons is joined to short pipe sections by inert-gas-shielded arc welding technique.*

M. W. Kellogg Co.



Acknowledgments

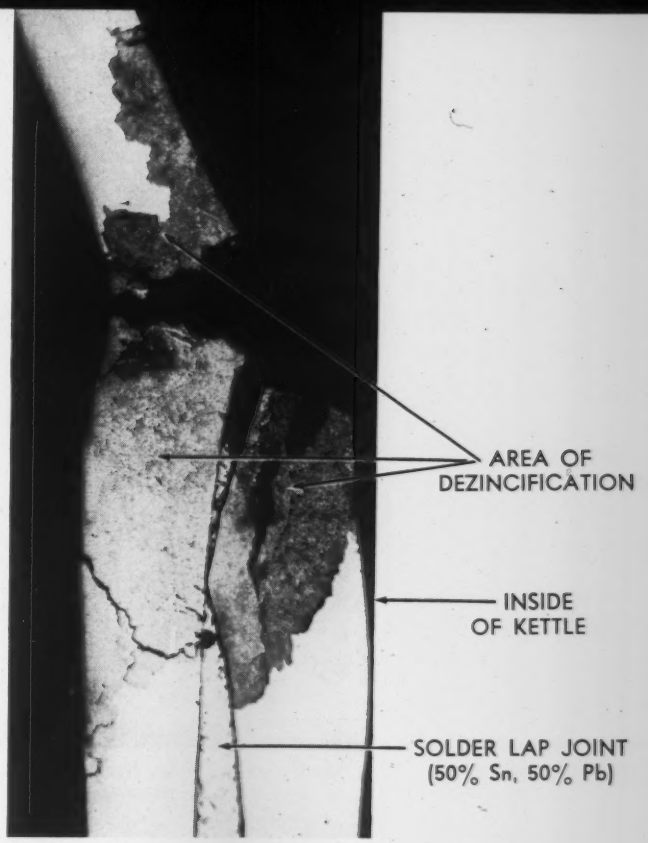
A short portion of this article was based on the paper "Development Associated with the Superpressure Turbine For Eddystone Station Unit No. 1," by W. E. Trumpler, Jr., et al, delivered as part of the Power Division's program at the annual meeting of the ASME in Atlantic City, N. J., at the beginning of this month.

The author would like to express his appreciation for the assistance of personnel and literature from the following organizations in preparing this article:

Combustion Engineering, Inc.
M. W. Kellogg Co.
Philadelphia Electric Co.
Westinghouse Electric Corp., Steam Div.

The Case of the Kettle that **Wasn't Copper**

by Oliver E. Olson
Research Laboratories, National Lead Co.



Vertical cross section *of kettle wall at largest diameter, i.e., adjacent to solder lap joint. Dark areas are brittle, porous copper deposit caused by dezincification.*

The victim: *a tea drinker*

There is a trend in the stores to feature household articles made of warm, rich copper and brass of Old World charm to replace items finished in chromium plate. But all too often the functional has been sacrificed to the ornamental. This lesson was learned the hard way by a woman in a large Eastern city who purchased what looked like a copper tea kettle in a department store.

When she used this kettle to boil water, the lower half of the tea kettle separated from the upper half as she was removing it from the stove. She claimed that the boiling water from the fractured tea kettle scalded her body. She sued the department store. Since the tea kettle was an import, the department store in turn sued the importer.

The alibi: *a boiling water test*

The importer's only recourse was to establish whether or not a similar tea kettle would separate at or near the seam in normal use. A kettle from the same lot was used to boil water for several days, but failed to separate at or near the seam. The importer then submitted this kettle for a metallurgical examination in order to defend himself in court.

Metallurgical examination revealed that the entire kettle was not copper but yellow brass consisting of approximately 70% copper and 30% zinc. The outside of the kettle was copper plated and buffed to simulate polished copper. The upper half of the kettle was joined to the lower half with a soldered lap joint which was in good condition.

The weapon: *dezincification*

Near the soldered joint, however, there was considerable dezincification. It extended through the entire 0.014-in. wall of the kettle (see photo). It is possible that if the importer had boiled water in the kettle for an additional day, this kettle too would have failed due to dezincification.

Dezincification is an electrolytic form of corrosion common to brass where moisture is present. As the brass goes into solution, the copper is plated back as a porous brittle metal in the cavity occupied by the brass. The zinc stays in solution in the hot water and, if allowed to build up, forms a gray zinc oxide crust. Spectographic examination of the gray crust formed in this kettle confirmed presence of appreciable zinc.

Dezincification may have been triggered by forming, scoring or over heating; heating, for example, can start dezincification because of the relatively high vapor pressure of zinc as compared to that of copper. Once water comes into contact with the brass, dezincification proceeds continuously, for a kettle seldom dries out. Dezincification can be expected even at room temperature, but the rate is much faster at the boiling point of water.

The culprit: *a careless manufacturer*

The manufacturer failed in many ways. He should have specified on the label that the tea kettle was not copper but a brass product simulating copper by plating. He should have specified to his supplier that the brass sheet contain 1% tin to inhibit dezincification. He should have applied a heavy coating of pure tin to the inside of the tea kettle (a tin coating was used—but so thin that it had all but disappeared after the prolonged boiling). And he should have used a lock seam instead of a simple lap seam, so that even if the solder were to run out when the kettle was heated without enough water, the seam would not separate.

But failure of the kettle was not the only consideration. The Public Health Service specifies that potable water should contain less than 17 ppm of zinc. Boiling water in such a tea kettle could dissolve zinc in catastrophic proportions.

The verdict: *customer right again*

The importer apparently agreed that this was no one's cup of tea. He settled with the customer out of court.

Sheet, *such as these methyl methacrylate light diffuser panels, is strengthened and toughened by biaxial orientation.*

Film, *such as this polyester type being laminated to refrigerator door liners, becomes glossier and clearer, as well as tougher, when biaxially oriented.*

You can get stronger, tougher parts with

Oriented Thermoplastic Sheet and Film

Biaxial orientation—stretching a material to line up the molecules—changes the properties of almost all thermoplastics. Here's what you get. . . . and how to design with such materials.

by C. P. Fortner, *Vice President, Research and Development and* **P. Dalton,** *Project Engineer, Plax Corp.*

■ Increased mechanical strength and toughness are the two primary attributes of oriented thermoplastic sheet. Other properties such as resistance to crazing, aging and weather may also be affected by orientation of some thermoplastics.

Although oriented plastics carry a premium, the resulting materials cost is usually the same, or even lower, in comparison with ordinary plastics because of the thinner sections made possible by the greater strength.

What orientation does

Since orientation is a molecular rearrangement only—not a chemical change—it primarily affects directional properties; bulk properties remain relatively unaffected. The box on p 96 outlines in detail what happens when thermoplastics are oriented, both uniaxially and biaxially.

One shortcoming of oriented thermoplastic sheet or film is the "elastic memory" imparted to the material by orientation. During orientation, the material is stretched, then cooled or "frozen" in the stretched state. Thus, the material has high internal stresses which tend to pull it back to its original shape. If the material is reheated to the orientation temperature it tends to revert to its original size. Thus, orienting places a temperature limit on the

material above which it will not simply deform slightly but actually contract to its original size.

Although both uniaxial and biaxial orientation are used for thermoplastics, biaxial orientation is assumed here unless otherwise specified. The box on p 96 explains the pros and cons of each type.

Since orientation is essentially stretching, it is usually expressed quantitatively as the percent increase in original dimension provided by stretching. For example, a 100% oriented sheet is one which has been stretched to twice its original dimension.

Which oriented thermoplastic?

Virtually all thermoplastics can be oriented to some extent. Amorphous materials orient more readily than crystalline ones. Crystallization is not a problem with polystyrenes and related copolymers, acrylics, polyesters and polycarbonates, since under normal conditions of polymerization and processing no appreciable amount of crystallization occurs. However, such materials as polyethylene, polypropylene, nylon and polyether undergo a considerable amount of crystallization during normal processing. Crystalline materials may exhibit a differential elongation or "necking" during the stretching process, causing sharp differences in thickness of the sheet. Successful orientation of such materials is usually done by quenching the sheet or film immediately after extrusion and before orienting, thus limiting the degree of crystallinity in the material.

The table on p 98 compares typical properties of unoriented and biaxially oriented thermoplastic sheet. Specific properties of an oriented sheet material depend on both the degree of orientation and the orientation temperature.

Polystyrenes

Orientation of polystyrene and styrene-acrylonitrile copolymers greatly improves tensile, compressive, flexural and impact strengths, and aging resistance. Toughness and flexibility are substantially improved. For example, a specimen which, unoriented, breaks at an angle of 44 deg when bent around a ⅛-in. mandrel, can be bent to an angle greater than 180 deg when oriented. Considerable evidence indicates that weather resistance of polystyrene is also improved some by orientation.

Acrylics

Orientation of polymethyl methacrylate produces property changes quite similar to those of polystyrene, though to a lesser degree. Tensile and flexural strengths, and elongation, increase. Impact strength, however, is relatively unaffected.

Polyesters

Unoriented polyethylene terephthalate film is quite brittle, with only moderate tensile strength, but it has excellent abrasion resistance, low moisture vapor transmission and good heat sealability.

Orientation substantially reduces brittleness, and more than doubles tensile strength. However, abrasion resistance, moisture vapor transmission and heat sealability suffer to a degree. Orientation also makes the film heat shrinkable, of obvious benefit in a variety of packaging applications.

Sarans

A crystalline polymer, saran (vinylidene chloride-vinyl chloride) must be heat conditioned to reduce crystallinity prior to orientation. However, oriented sheet, film and fiber have been widely available for some time.

In sheet materials, tensile strengths can be substantially increased, as shown in the table. Most sheet is unidirectionally oriented. In biaxially oriented sheet, also available, longitudinal strength is sacrificed somewhat in improving transverse strength.

Polyethylenes

All polyethylenes are somewhat crystalline (crystallinity increasing with increased density). Thus problems of "necking down," mentioned before, must be avoided.

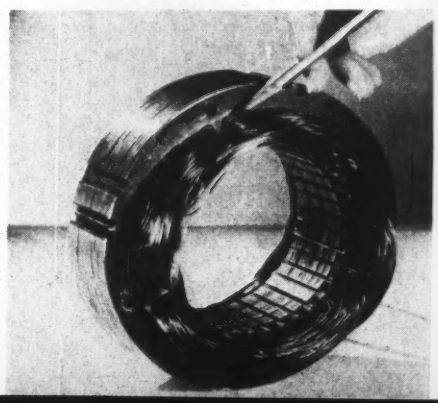
Polyethylene is particularly sensitive to degree of orientation and orientation temperature. For example, 100% biaxial orientation doubles tensile strength, reduces elongation by about one half, and doubles tear strength. On the other hand, a 300% orientation at a higher temperature triples tensile strength, reduces elongation to a third of original, and notably lowers tear and impact strengths.

Virtually all polyethylene film (both blown and slit-extruded) benefits from some degree of orientation, imparted during the extrusion and "take-off" process. In producing blown film the slight orientation that takes place is biaxial; however, most of the stretching is actually hot flow rather than orientation. Slit-extruded and quenched film is predominantly uniaxially oriented in the direction of extrusion.

One drawback of oriented polyethylene sheet or film is the decrease in dimensional stability resulting from orientation. Although tensile strength and directional tear strength are substantially improved, shrinkage increases, particularly with Type III (higher density) materials.

Quantitative correlations among degree of orientation, amount of shrinkage and improvements in strength are not complete. How-

Increased toughness *caused by biaxial orientation permits reduced thickness in polyester film used for motor slot liners.*



ever, in general, tendency to shrink seems to increase up to 100% orientation, after which it decreases. Studies have shown that a specimen with 100% orientation shrinks 2.25% after 100 days at 165 F, whereas a specimen with 350% orientation shrinks only 1%. Unfortunately studies indi-

Orientation—A Molecular Re-Arrangement

Essentially, orientation of thermoplastics—whether it be unidirectional or biaxial—is a process of stretching the material in a manner so as to line up the molecular chains in a predetermined direction. Once lined up, the ordered arrangement is "frozen" in a strained condition.

Heat loosens molecular ties

In stretch-orienting, and thus altering the basic molecular arrangement of a thermoplastic, three forces must be overcome: 1) covalent forces within the molecular chain itself, hooking carbon to carbon on the backbone, and to any side chains that are present, 2) the frictional constraining force caused by the intertwining of the spring-shaped molecules, and 3) the attraction existing between the molecules.

Heat is used to help overcome these internal forces. At room temperature, the translational and vibrational energy of the molecules themselves is less than the sum of the frictional constraining forces and the intermolecular forces. Thus, the molecules are "frozen" in place. As the temperature of the material is raised, the vibrational energy of the molecules increases, thus increasing both the distance between carbon atoms within the molecules and the distance between molecules. Increasing the distance lowers the constraining forces.

With further increases in temperature a point is reached where vibrational energy is just sufficient to overcome the intermolecular attraction and frictional constraining forces which prevent molecular motion. At this point, a pure solid substance would be said to "melt." However, within a polymeric material there is a wide difference between the sizes, and therefore the "melting points," of the various molecules. The term "softening point" is used to designate that temperature at which sufficient molecules have "melted" to cause a softening of the bulk material as determined by various standard tests. (Actually "second order transition temperature" is a more exact term describing the temperature at which molecular "freezing" is just overcome. This temperature often differs substantially from the observable softening point.)

How loosend molecules are oriented

Unoriented thermoplastics may be pictured as a mass of randomly arranged, intricately intertwined, spring-shaped molecules frozen in place. Orientation is the "ordering" of these randomly arranged molecules.

The most common method used to orient a thermoplastic is to stretch it after it has been heated to a temperature at which it is "soft." This temperature is below the "flow" temperature (at which the molecules would merely "slip past" one another when the material was stressed, with little intramolecular stretching.)

When the material is stretched at orientation temperature, two important things occur:

1. The direction of the molecules in the material is changed. A rotating force is exerted which pulls or turns the entangled molecules in a direction more nearly approaching the direction in which the material is stressed. The force required for this unravelling of entwined molecules is that needed to overcome the sum of the friction-like forces exerted by side-chain entanglement, and intermolecular attraction. This force is nonrecoverable.

2. The molecules are extended like springs. The force needed for this extension is that required to overcome the bonding forces (interatomic bonds) and shape-forming forces (interatomic bonding angles) within the backbone of the molecules. As in a coiled spring, the resulting strain is an elastic deformation, and as such the force is stored as potential energy, recoverable when molecular strain is relieved.

While the molecules are held in this extended spring configuration, the temperature is dropped below the softening point of the material. This cooling reduces the vibrational energy of the molecules to below the sum of the intermolecular attractive forces and the mechanical constraining forces, and freezes the molecules in that strained position.

The potential energy stored in the extended molecules is the source of the "elastic memory" characteristic of oriented thermoplastics. That is, when the material is reheated to the orientation temperature, the molecules tend to return to their original size and spatial arrangement.

Uniaxial vs biaxial orientation

The direction of alignment and stretch of molecules, of course, depends on the direction in which the material is stretched. Orienting or aligning the long chain-like molecules in one direction puts them in the best load-bearing position if the material is to be stressed in tension in that direction. However, the tensile load-bearing ability of such a uniaxially oriented material in the direction perpendicular to that of orientation is much lower, since an applied stress tends to pull adjacent molecules apart, rather than pulling along the molecular chain axis.

Biaxial orientation aligns molecules in both the transverse and longitudinal directions. It provides a primarily planar molecular structure, with the axes of the molecules nearly parallel to the sheet surfaces. Such an arrangement does not provide the maximum strength, since the molecules are not in the optimum load-bearing position, but it provides a balance of improved strength characteristics — both longitudinal and transverse.

cate that this 100% orientation level where maximum shrinkage occurs is also the orientation level providing maximum tear strength.

Polypropylene

A stereospecific polymer, polypropylene is relatively new, and difficulty is still being encountered in producing a biaxially oriented sheet or film with balanced properties.

In general, tensile strength can be more than doubled by orientation, but strengths in the longitudinal and transverse directions are not balanced. Elongation is greatly reduced, and the material no longer has a discernible yield point. Also, biaxial orientation of film reduces permeability to vapors, and improves solvent resistance, stiffness and transparency.

Shrinkability of oriented film causes distinct problems in heat sealing; however, impulse sealing can be performed with very little loss of stability or strength.

Polypropylene has a moderate degree of crystallinity, and thus is subject to problems similar to those of polyethylene in cold stretching. Film is usually quenched rapidly after extrusion to prevent crystallization and improve clarity. During production, film can be stretched in the machine direction by a "drawdown." However, such film is only strong in the machine direction. Biaxial orientation overcomes this imbalance to some degree, but as mentioned before the property balance obtainable to date is still not satisfactory.

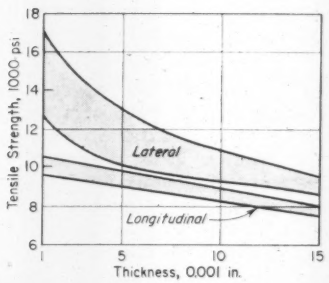


***Fig 1**—Effect of thickness on tensile strength of biaxially oriented polystyrene sheet.*

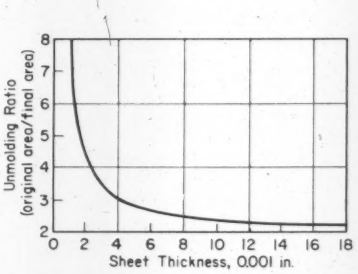


***Fig 2**—Effect of thickness on unmolding ratio of polyethylene—a measure of degree of orientation within the sheet.*

Rubber hydrochloride

Although available commercially only in oriented form, rubber hydrochloride film (Goodyear Chemical Co.'s Pliofilm) is included here for the sake of completeness. The film depends on orientation to provide its desirable properties of toughness, tensile strength and flexibility.

Other thermoplastics

Effects of orientation on several other thermoplastics have been determined. None of them are available commercially in oriented form.

Polycarbonates—Polycarbonates have not been produced commercially long enough to be fully evaluated. However, under proper sheet preparation and temperature control, successful orientations of up to 200% have been reported. The values in the table show that tensile strengths are more than doubled, while elongation is substantially reduced.

Rigid vinyls—At 200% orientation, tensile strength of rigid PVC (polyvinyl chloride) is doubled; elongation drops to about 15%. Ordinary PVC is very compatible with plasticizers and other compounding ingredients which can be used to provide a variety of desired property variations. Thus, until the recent interest in shrinkable films (shrinkability being induced by orientation), there was little commercial demand for orientation.

Nylon — Nylon monofilaments unidirectionally oriented to provide high tenacity are well known; oriented nylon sheet on the other hand is far from common. The melt-flow characteristics of nylons make orientation an extremely critical operation.

Under very closely controlled conditions, nylons can be biaxially oriented to provide greatly improved tensile strength. Some preliminary studies carried out about five years ago with type 610 nylon indicate that tensile strength could be more than doubled, elongation being reduced by about half.

The increasing use of type 6 nylon with melt-flow characteristics different from those of the older type 66, and the subsequent increase in availability of nylon sheet (see "A New Look at Nylon Plastics," M/DE, Dec '58, p 94) may lead to increased interest in biaxially oriented nylon sheet.

TFE fluorocarbon; chlorinated polyether—Both TFE fluorocarbon (Du Pont's Teflon) and chlorinated polyether (Hercules' Penton) have been successfully oriented, with the resultant changes in tensile properties shown in the table. These materials are not commercially available in oriented form, evidently because the improved values exceed those now required for most applications.

How to design with oriented plastics

Strength vs section thickness

Of primary interest to the materials user is the minimum thickness of material necessary to provide adequate strength. In sheet plastics, tensile strength per unit area increases with decreasing thickness. This relationship for biaxially oriented polystyrene sheet is shown in Fig 1. In the case of oriented thermoplastic sheet, the degree of molecular orientation within the sheet also varies inversely with sheet thickness, as shown in Fig 2. Thus, as thickness decreases, both of these

TYPICAL PROPERTIES OF THERMOPLASTIC SHEET—NORMAL VS

		Polystyrene[a]		Styrene-Acrylonitrile Copolymer		Acrylic (polymethyl methacrylate)		Polyester Film (polyethylene terephthalate)		Saran (vinylidene chloride-vinyl chloride)		Rubber Hydrochloride Film[b]
		Normal	Oriented	Normal	Oriented	Normal	Oriented	Normal	Oriented	Normal	Oriented	Oriented
	ASTM											
Ten Str, 1000 psi	D882	5-9	7-12	9.5-12	10-15	7-8	8-11	8-10	17-23.7	3	8-20	3-5
Elongation, %	D882	1.0-3.6	10-20	1.5-3.5	40-60	2-7	60-80	3-5	35-110	140	2-120	200-800
Mod of Elast in Tension, 10^5 psi	D882	4-5	4.5	—	—	4.5	—	—	—	0.7-2.0	0.7-2.0	—
Flex Str, 1000 psi	D790	12-16	>10	14-19	15	12-17	13-17	—	—	15-17	Flexible	Flexible
Impact Str (Izod), ft-lb/in. notch	D256	0.3-0.4	3	0.4-0.5	3	0.4-0.5	0.4-0.5	—	—	2-8	—	Stretches
Max Rec Cont Svc Temp, F°		190	175	190	185	190	155	300	250	170	150	180
Effect of Sunlight (prolonged exp)		Not suitable	Not suitable	Yellows slightly	Yellows very slightly	Nil	Nil	—	Moderately resistant	Slight discolor	—	Fair resistance

[a]Polyflex sheet and film (Plax Corp.); Trycite film (Dow Chemical Co.).
[b]Pliofilm (Goodyear Chemical Co.).
[c]Penton (Hercules Powder Co.).
[d]Teflon (E. I. du Pont de Nemours & Co., Inc.).
Source: Most data on normal sheet taken from *Modern Plastics Encyclopedia Issue*, '59, Breskin, New York.

factors work together, increasing strength per unit cross section.

In Fig. 2 the relatively sharp transition range in orientation vs thickness which occurs in the neighborhood of 3-mil thicknesses should not be taken as a limit on thickness. Degree of orientation is much more a function of stretching temperature and temperature conditioning than of thickness. Plastics sheet manufacturers should be able to supply orientation-thickness curves for the particular material specified.

Thermoforming Oriented Sheet

Because of 1) the strained condition of oriented sheet, and 2) the fact that thermoforming processes for sheet and film are carried out at temperatures above the softening point of the material, an understanding of some of the problems unique to thermoforming oriented sheet will be of help in working with your molding supplier.

Vacuum forming ticklish

Vacuum forming biaxially oriented sheet by conventional techniques is a ticklish job, requiring experience and rigid controls. During the heating cycle, oriented sheet first expands. The heaters warm the top of the sheet before the bottom, causing considerable buckling or contortion. As heating continues, however, internal stresses tend to contract the sheet, and it flattens out and tightens like a drum-head.

The critical period begins when the sheet has tightened. It then begins to soften under continued heating. Vacuum must be applied at precisely the right moment during softening to ensure proper material distribution and formability.

After forming, the cooling cycle before release from the mold is similar to that of unoriented sheet, except that the higher degree of orientation in the sheet provides a much stronger force tending to pull the formed sheet back to its former shape.

Trapped sheet process is recommended

Several of the drawbacks of conventional vacuum forming, such as uneven heating and insufficient forming pressure, are eliminated by the use of the so-called "trapped sheet process." The oriented sheet is held in place by rim clamps and cold formed by compressed air into a shallow inverted dish shape. A contact heater is then lowered to touch the stressed sheet and start the heating cycle. As the sheet heats and expands, the sheet area in contact with the heater progressively increases. Thus, stretching stresses are continually being relieved as the sheet approaches forming temperature. Correct heater shape can help in locating accumulations of material in various areas of the part.

When the forming temperature is reached, the sheet is abruptly blown down away from the heater platen into the mold. The air pressure used to form the sheet in the mold varies with depth of draw, fidelity desired, and degree of sheet orientation.

An additional benefit of this process is the use of the "trap" (rim clamps) to form the outer edge of the molding. Where a lip or rim is desired on the outer edge of parts such as container covers or cups, the sheet clamping device can be actuated so that when the sheet reaches forming temperature, the clamping rim moves down, molding the rim.

BIAXIALLY ORIENTED (Values Cover 100-300% Orientation Range)

Polypropylene		Type I Polyethylene		Not Commercially Available Biaxially Oriented									
				Type III Polyethylene		Polycarbonate		Rigid PVC		Chlorinated Polyether[e]		TFE Fluorocarbon[d]	
Normal	Oriented	Normal	Oriented	Normal	Oriented	Normal	Oriented	Normal	Oriented	Normal	Oriented	Normal	Oriented
5-12	15-30	1.7	3-7	2.8-5.5	6.8-7.2	9-10	16-24	8	15	6	15-20	2.7	2.5-3.0
300-550	40-150	600	300	700	200-300	180	32-40	5-60	16	60-160	50-100	220	210-250
1.3-2.0	—	0.2-0.3	—	0.8-1.5	—	3.14	—	3.5-4.0	—	1.3	—	0.58	—
7.9	—	—	—	2.4	—	11-13	—	10	—	5	—	—	—
17	—	17	—	2-12	—	14	—	0.7-0.8	—	0.4	—	3.0	—
275	200	210	—	250	130	290	—	150	—	300	—	500	—
Crazes[f]	—	Crazes[f]	—	Crazes[f]	—	—	—	—	—	Very slight	Slight	None	—

[e]Values for oriented materials represent maximum use temperature above which elastic memory causes tendency to return to original dimensions.

[f]Unpigmented; carbon black filler substantially improves weatherability.

In specifying oriented sheet, care should be taken to investigate and specify the degree of orientation necessary to provide the optimum combination of strength and formability. Although a high degree of orientation is desirable where maximum strength is required, a lesser degree is desirable for sheet which is to be formed.

There is a point beyond which each material should not be stretched. In polystyrene, for example, this limit is in the neighborhood of a 30:1 area increase. Remember that the action of the sheet as it is drawn into the mold during forming provides a further degree of orientation, dependent on the depth of draw. Thus, besides the fact that a highly oriented sheet may introduce undue constraining forces during forming (see box on p 98), the sheet may be so highly oriented that it cannot be further stretched to the draw depth required.

Shape considerations

The two major thermoforming methods for which parts must be designed are pressure forming (such as used in the trapped sheet method), and vacuum forming. Several special design considerations must be taken into account when designing parts from oriented sheet:

formed over a male mold, at least 5 deg draft should be incorporated. Lesser draft may cause difficulty in removing parts, since the oriented sheet tends to pull tighter onto the mold as it cools.

Radii—Radii on external corners and edges of male molds should be at least 1/16 in. The tendency of oriented material to tighten on the mold during cooling may result in excessive stretching over smaller radii. On very thin sheet, radii of corner fillets should be at least 1/16 to ⅛ in. Thicker sheets, 10 mils and over, require fillet radii of at least ¼ in.

Projections — The webbing effect in oriented sheet is about the same as that encountered in non-oriented sheet. In some instances where non-oriented material is deep drawn, plug-assist between projections on the male mold has been used to improve detail. In oriented materials, plug-assist is not feasible as it may cause cold spots and excessive mark-off on the final part. The best solution is to space projections as far apart as possible.

Depth of draw—In determining depth of draw possible, area increase is a much more useful and practical criterion than depth of draw. Actually, the section of sheet that will undergo maximum area increase is the controlling factor.

In general, sheet area increases in percent should not exceed ten times the sheet thickness in mils. For example, 5-mil sheet should not be subjected to greater than a 50% area increase; 10-mil sheet to 100%; 20-mil sheet to 200%. Of course, these are only approximate limiting values.

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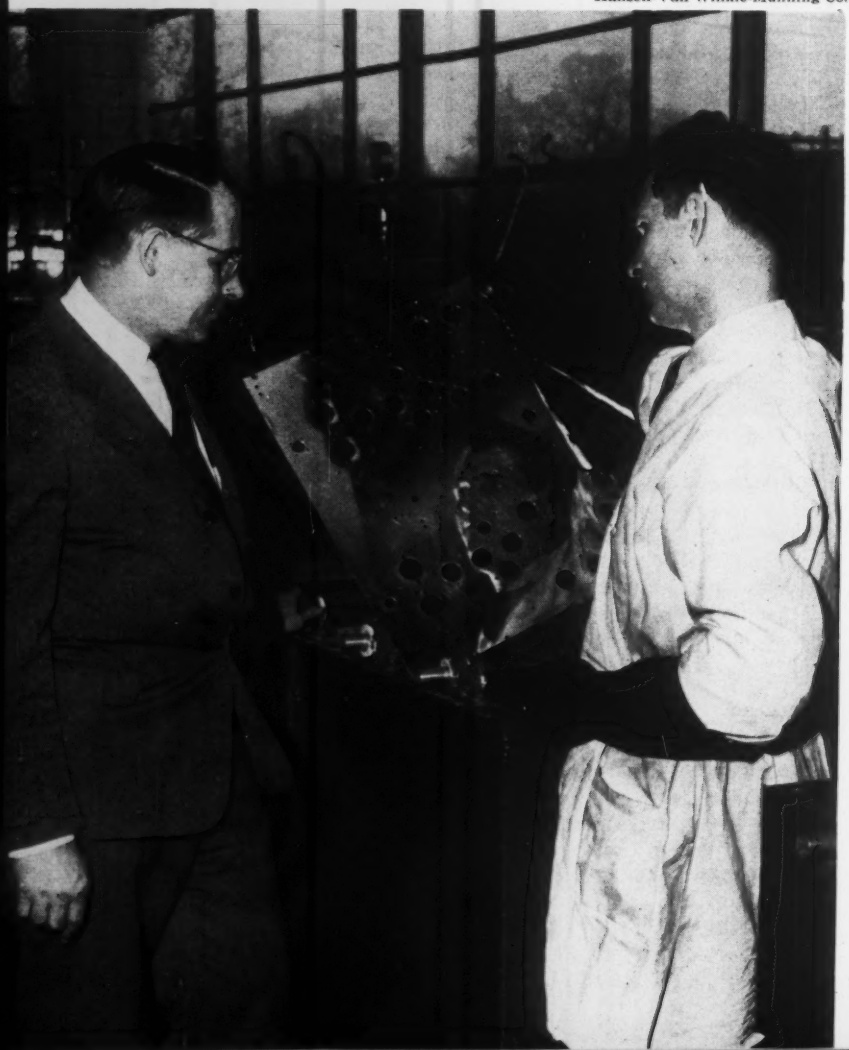
Zinc and Cadmium Electroplates

- *Provide good corrosion protection*
- *Improve appearance*
- *Apply easily*
- *Are inexpensive*

by **Robert L. Buckley,** *Industrial Chemical & Equipment Co.*

Bright cadmium *electroplate on electronic chassis stamping combines good appearance with corrosion protection.*

Hanson-Van Winkle-Munning Co.



■ The popularity of zinc and cadmium electroplates over the years stems from their excellent ability to protect iron and steel surfaces from corrosion. These electroplates are very easy to apply and, depending on the plating bath used, are deposited rapidly. Here is a description of how they compare, where they are used, and how they are applied.

How they compare

Appearance

Zinc and cadmium electroplates can be produced with either a dull or a bright finish.

Zinc has a gray matte appearance when deposited from a common cyanide plating bath. A mirror-bright appearance is obtained by adding suitable brighteners (usually organic) to the plating bath. Bright coatings are less susceptible to finger tarnishing or staining than the dull coating. Since the bright finish is relatively easy to obtain, it is specified more frequently than a dull finish. However, zinc, being an active metal, tends to lose its initial appearance much more rapidly than other electroplates such as bright nickel or chromium.

Cadmium electroplates generally have a close resemblance to zinc electroplates. However, it is easier to obtain higher brightness and luster with zinc electroplates because of the higher efficiency of the brighteners used in zinc plating baths.

The appearance of both zinc and cadmium electroplates can be further improved by using a chromate conversion treatment. In addition to improving corrosion resistance, such a treatment provides greater brightness, makes brightness last longer, and improves paint bonding.

Whether or not a chromate treatment is used, bright zinc and cadmium electroplates are rarely buffed or polished.

Zinc and cadmium electroplates can also be colored by dyeing. A

Allied Research Products, Inc.

Chromate conversion coating *is used over zinc-plated trunk hardware (left) to improve corrosion resistance, paint adhesion. On zinc-plated dish rack, movie reels and handles, coating enhances appearance, lengthens life.*

deep black color can be obtained by dyeing the electroplate directly. Blue, red, green, orange and other colors can be produced by dyeing a chromate conversion coating which is applied over the electroplate. These dyes do not color the electroplate, just the conversion coating. The colors have a pleasing appearance and are mainly intended for use indoors to improve appearance and for parts identification. They are not recommended for outdoor use because of their poor lightfastness when exposed to sunlight and weathering.

Corrosion resistance

Zinc—Zinc electroplates display their greatest advantages in relatively dry applications. During dry, outdoor exposure a zinc electroplate reacts with the oxygen in the air to form a thin, dense, oxide layer which tends to retard corrosion. At a certain point in its development the outer surface of this layer becomes porous; the oxide then forms a basic carbonate which tends to accelerate corrosion. However, this type of corrosion is not severe, and proceeds at the rate of roughly 0.1 mil annually.

Zinc electroplates corrode fastest when they are exposed to water or moisture laden atmospheres, especially in industrial atmospheres where the air may contain smoke, oxides of sulfur, ammonia and other contaminants. In such atmospheres a zinc electroplate forms an extremely soluble compound of zinc sulfate and zinc hydroxide which tends to wash away. Nevertheless, because of its sacrificial properties the electroplate continues to provide excellent protection to the base metal.

More specifically, as soon as a portion of the electroplate is removed—through corrosion, wear or damage—an electrolytic cell is formed. This cell is made up of the moisture in the air, the base metal and the zinc coating. The zinc dissolves sacrificially and the corrosion products formed tend to slow down the corroding action. Thus, the base metal is protected against attack until there is no more zinc left to corrode or dissolve. This action explains why zinc, although itself corroding, is so popular for protecting ferrous metals.

Depending on exposure conditions, zinc electroplates are usually applied in thicknesses of 0.2 to 1 mil or more. In rural outdoor exposures, a thickness of 0.2 to 0.5 mil provides good protection. For more severe use in industrial or coastal areas, a thickness of 1 mil or more should be applied. Following are some typical corrosion rates (in oz per sq ft per yr) obtained in typical atmospheres: rural—0.021, marine—0.062, urban industrial—0.181. These rates (obtained with 0.5-mil coatings with no conversion or supplementary coatings) should be taken into account when designing parts for outdoor exposure.

Cadmium — Cadmium electroplates also protect ferrous base metals by sacrificial corrosion. In general, cadmium electroplates do not perform as well as zinc electroplates in industrial atmospheres. On the other hand, cadmium electroplates last substantially longer than zinc electroplates in marine environments. Cadmium electroplates may form copious white corrosion products in marine environments, but this type of deterioration can be reduced considerably by using a suitable chromate conversion coating.

Three different grades and thicknesses of cadmium electroplates —0.15, 0.3 and 0.5 mil—are re-

commended by ASTM for different service conditions. Other thicknesses can, of course, be used for unusual service conditions.

Hardness

Zinc and cadmium electroplates are relatively soft and are not normally used where hard, wear resistant surfaces are needed. Next to tin, cadmium is one of the softest deposited metals. It has a Brinell hardness of 12 to 22 as deposited and about 20 when annealed. Zinc has a Brinell hardness of 40 to 50 as deposited and 40 to 45 when annealed. Because of their softness and good forming properties, both zinc and cadmium electroplates can be applied prior to stamping, punching, shearing and other forming operations.

Thermal and electrical properties

The coefficients of thermal expansion (at 68 F) of zinc and cadmium electroplates are 22 x 10^{-6} and 16.6 x 10^{-6}, respectively. Zinc electroplates have an electrical resistivity (at 68 F) of 5.916 microhm-cm as compared to 6.83 for cadmium. It is interesting to compare these metals with silver which has a resistivity of 1.59 microhm-cm.

Cost

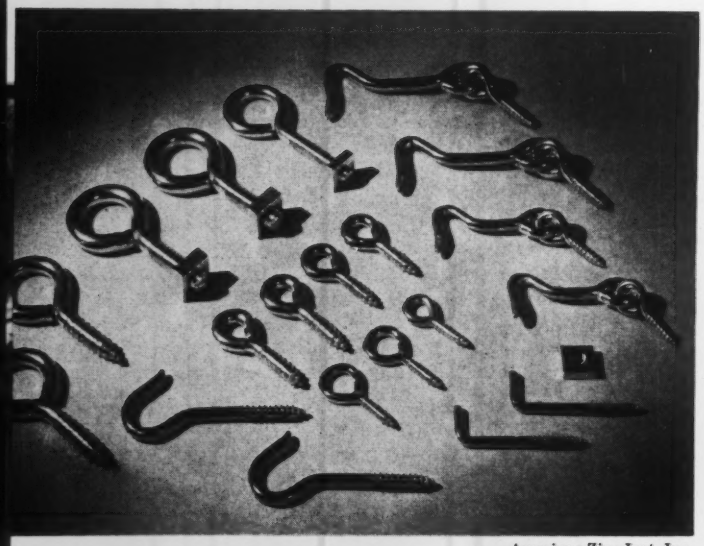
The labor and processing costs involved in producing these coatings are roughly equal for zinc and cadmium. However, cadmium electroplates are more expensive than zinc electroplates, since zinc cadmium plating anodes ($1.30 per lb) cost considerably more than zinc plating anodes ($0.18 per lb). Despite their higher cost, cadmium electroplates are very competitive with zinc electroplates, mainly because of their better corrosion resistance under certain conditions.

Where they are used

Zinc

The main advantage of zinc electroplates is their ability to provide corrosion protection at low cost. At one time zinc electroplates were mainly used in functional applications. However, with

Many surface effects are obtainable with zinc electroplates



American Zinc Inst. Inc.

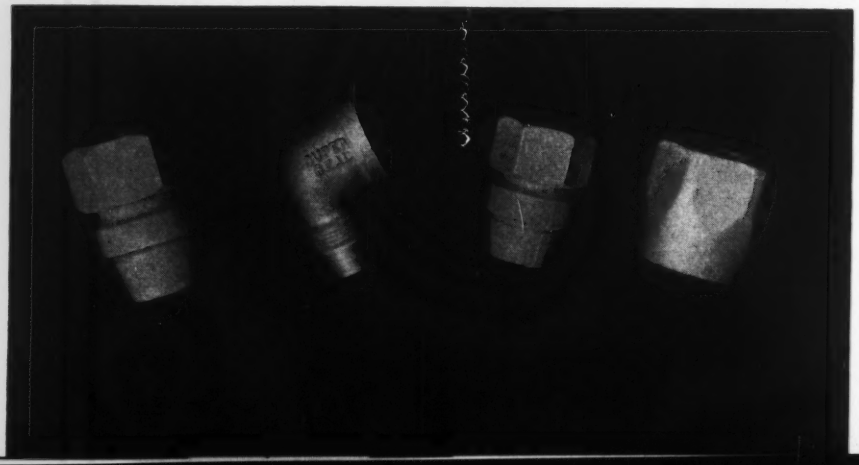
Smooth, bright finish *is used on small zinc-plated fasteners to enhance appearance, heighten sales appeal.*

Medium gloss finish *on zinc-coated hardware provides pleasing appearance.*

Hanson-Van Winkle-Munning Co.

Dull, matte *zinc plate is used on these gray iron and malleable iron couplings where appearance is not important.*

Hanson-Van Winke-Munning Co.



the development of bright finishes and improved supplementary coatings, zinc electroplates are used increasingly in decorative applications. Zinc electroplates are quite popular in finishing small parts such as pipe couplings, bolts, nuts, rivets, washers, and nails; other miscellaneous hardware items such as hinges, hangers, hooks and buckles; and larger items such as electrical conduit pipe, silo rods and tie rods. They can also be used to protect and decorate metal screening, steel wire and strip, and iron and steel castings.

Cadmium

Cadmium electroplates are widely used on radio, television and other electronic chassis. An important advantage in such applications is that the electroplates have little or no effect on post-soldering operations.

These plates are used on numerous outdoor aircraft, marine and military parts requiring corrosion protection. They have less tendency to form corrosion products than zinc electroplates and are frequently used on screws, nuts and other threaded parts to avoid jamming.

Cadmium electroplates also resist the corrosive action of weak alkalis. This property has proved important in washing machine applications. Cadmium electroplates also have better resistance than zinc electroplates to the alkaline products produced in curing concrete and masonry. Thus, they are increasingly used on structural parts that come in contact with, or must be embedded in, concrete or masonry.

How they are applied

An important reason for the popularity of zinc and cadmium electroplates is the ease with which they can be applied to practically all base metals. Following are recommended processing cycles for electroplating zinc and cadmium on the most commonly used base metals. These cycles have been proved over many years. Space does not permit inclusion of all processing cycles and you should keep in mind that there are other processing variations which are quite satisfactory.

Processing cycles

Vapor degreasing, although optional, is recommended before electroplating all ferrous and nonferrous metals with zinc and cadmium. The most commonly used solvent is stabilized trichlorethylene, although perchlorethylene is recommended for some applications.

Plating ordinary steels—If degreasing is not used, parts must be cleaned in an appropriate alkaline cleaner. This step is essential to promote adhesion of the electrodeposit. It is usually followed by a water rinse and then by an acid dip which produces a fine etch on the base metal. The acid dip is followed by a water rinse and then by a cyanide dip. After the cyanide dip the parts can be electroplated with the appropriate solution under the conditions described in the next section.

After electroplating, the parts are given a water rinse, a bright dip (a number of proprietary dips are available), and a final water rinse before drying.

Plating high carbon steel—Mild or short acid pretreatments are recommended when coating high carbon steels in order to prevent hydrogen embrittlement. Following are typical recommendations:

Initially, the parts should be electrocleaned. This step is followed by a water rinse, a brief acid dip, and another water rinse. At this point a smut removal step may be necessary on some high carbon steels. Smut can be removed either by a dip or by an anodic treatment in a sodium cyanide solution. Next, parts are rinsed, etched in a sulfuric acid solution, and rinsed. At this point the parts can be electroplated.

Plating copper and brass—As with steel parts, copper and brass should first be cleaned in an alkaline cleaner to remove all contaminants. Cleaning should be followed by a water rinse, a brief acid dip, and another water rinse. A brief cyanide dip is recommended before electroplating.

Plating cast iron—It is strongly recommended that cast iron be shot blasted prior to cleaning when parts are to be zinc electroplated. With this one important exception, the same processing cycle can be used in electroplating zinc or cadmium.

Initial treatment consists of a vapor degrease followed by an electrocleaning operation and a water rinse. Then use an acid treatment for as long as it takes to remove smut which may be left by the electrocleaner. Following a final rinse, the parts can be electroplated.

Plating solutions

Zinc—Zinc can be deposited from either acid or alkaline solutions. Available alkaline solutions include cyanide, zincate and pyrophosphate types. Typical acid solutions include chloride, sulfate and fluoborate. Many variables are involved in selecting the best solution. However, it has generally been found that the alkaline cyanide-type solutions have the best all-around combinations of properties.

A basic standard cyanide-type solution commonly used is prepared with zinc cyanide (8 oz per gal), sodium cyanide (5 oz per gal), caustic soda (11 oz per gal), and a brightener (as required). This solution is operated at a current density of 20 to 50 asf at a temperature of 70 F.

Cadmium—Like zinc, cadmium electroplates can be deposited from either an acid or an alkaline solution. In addition to the most commonly used alkaline cyanide solution described below, sulfate and fluoborate acid solutions are also commercially available.

The alkaline cyanide solution is prepared by mixing cadmium oxide (4 oz per gal), sodium cyanide (12 to 18 oz per gal), and sodium hydroxide (1 to 1.5 oz per gal). This bath is operated at a current density of 25 to 45 asf at a temperature of 75 F.

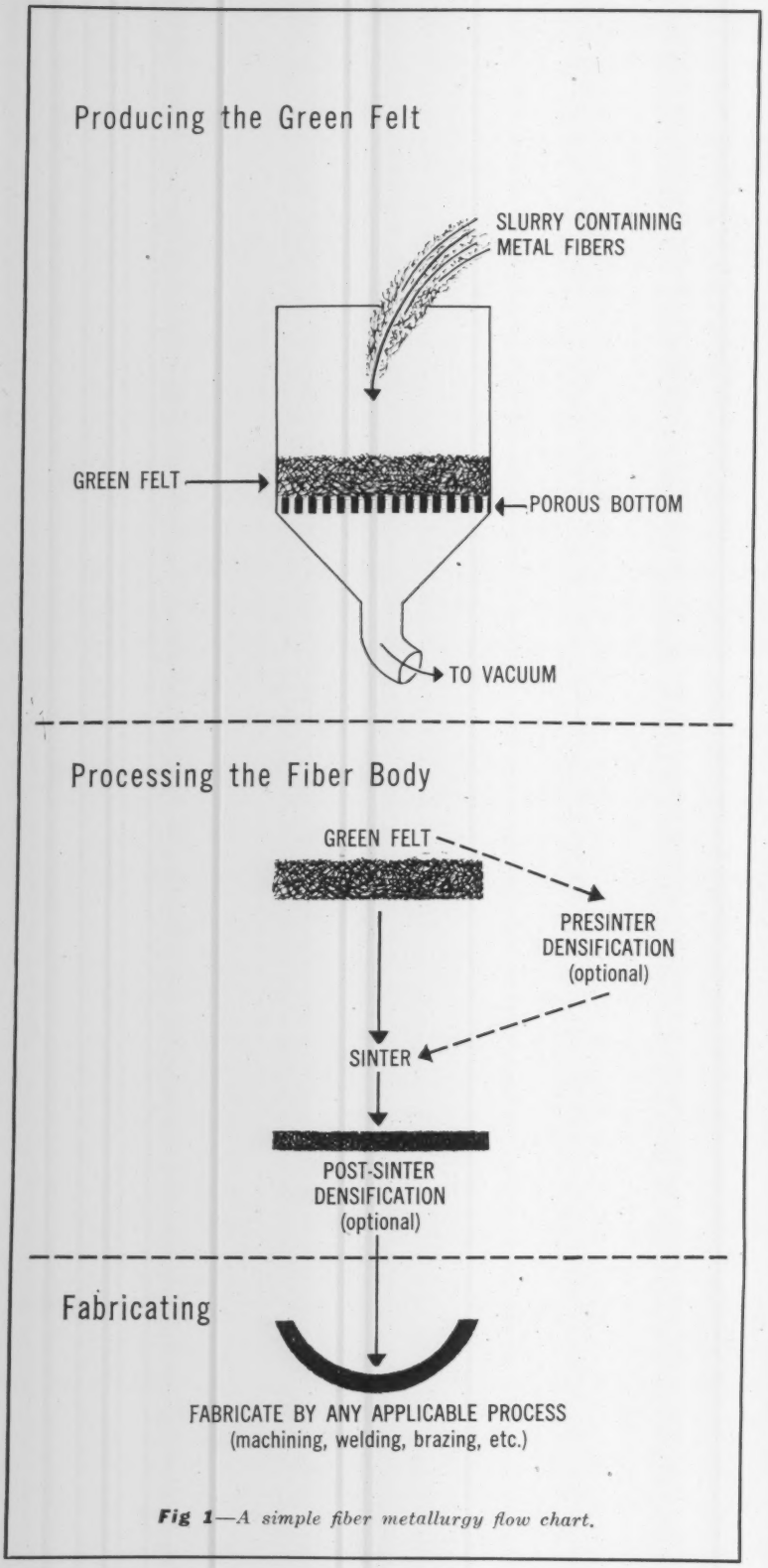


***Fig 1**—A simple fiber metallurgy flow chart.*

Fiber Metallurgy

A Progress Report

First described in M/DE four years ago (Nov '55, p 96), this new engineering material shows promise for filtration . . . sound absorption . . . vibration damping . . . reinforcing.

by Dr. Robert H. Read,
Supervisor, Physical Metallurgy Research, Armour Research Foundation

■ Borrowing a page from the paper chemist's book has helped metallurgists develop metal fibers into a new group of engineering materials. Applications range from improved filters and battery plates to fragmentation armor and rocket nozzles.

The basic technique of fiber metallurgy is to "felt" the metal fibers, as in papermaking, and then sinter the felted fibers. The randomly interlocked fibers are therefore joined metallurgically at each point of contact between them.

The metal fibers are generally coarser than the usual paper or cloth varieties (up to 0.015–0.020 in. in dia and up to 1 in. long). Fine fibers, less than 0.001 in. in dia and 0.010 in. long, have also been employed. Still finer fibers are of interest but are generally not available.

Fibers are prepared from metal wools, wires, filaments or turnings

which are chopped or milled to produce discrete fibers. The fibers, which can be made either the same length or in random lengths, are then crimped or beaten to obtain random three-dimensional kinks.

Some materials which have been treated are lead, copper, iron, nickel and cobalt-base alloys, titanium and molybdenum. It would appear that no metal or alloy is impossible to treat by fiber metallurgy techniques, although those which form stable surface oxides (such as aluminum) are difficult to sinter.

The process

To produce the "green" metal fiber forms, fibers are suspended in a liquid slurry which is poured into a mold with a porous bottom. As the liquid is withdrawn, the fibers are deposited uniformly throughout the fiber mass. If insufficient fibers are deposited at any one site, the increased permeability at that point increases the rate of flow of the slurry (and hence, fiber deposition). The felts may be complex in shape, large in size, or in the form of continuous strip. Resulting porosity may be as great as 97%. Further densification or shaping before sintering may be obtained by normal manufacturing processes such as extruding, coining or rolling.

The "green" felt is transformed into a rigid three-dimensional fiber network by sintering in a reducing atmosphere at a high enough temperature to obtain a diffusion bond between contacting fibers. The fiber bodies can then be further compacted, rolled, machined, welded, brazed or treated in a variety of ways to fabricate final components with porosities of from 5 to 97% and a wide range of controlled pore sizes.

The entire process is shown schematically in Fig 1.

Properties

Strength of fiber metallurgy products will depend on several factors: the metal used, effectiveness of diffusion bonding, and degree of porosity. Although comprehensive data are not available at this time, several tables and graphs will give engineers and designers some idea of the potential of metal fibers. The porosities at which various strength levels are achieved in fiber bodies produced from AISI 430 stainless steel are shown in Table 1. As expected, strength increases as density increases. A comparison of mild steel fibers in Fig 2 further shows the density-strength relationship.

Permeability to both air and water is shown in Fig 3. Permeability of the sintered fibers depends on the raw material used in felting, as shown by the considerable difference in fiber products produced from wire and wool.

TABLE 1—POROSITY AND STRENGTH OF METAL FIBER BODIES
(Type 430 Stainless Steel)

Ultimate Tensile Strength, psi	Porosity, %[a]						
	Iron Fiber, P, S	430 Stainless Steel Fiber					
		Fine P, S	Fine P, S, C, S	Fine, Ann., P, S	Fine F, P, S	Medium F, P, S	Coarse F, P, S
5,000	—	55	—	—	—	—	—
7,500	50	49	—	—	—	54	—
11,000	40	39	—	34	—	40	—
15,000	30	31	—	25	38	34	36
20,000	—	20	—	16	32	28	25
25,000	—	13	25	—	27	24	16
30,000	—	—	16	—	—	21	9

[a]F=felted; P=pressed; S=sintered; C=coined.

TABLE 2—SOUND ABSORPTION (%)

Sound Frequency, cps	Sintered Stainless Fiber Body (2½ in. thk)	Unbonded Fiberglas Batt (3 in. thk)
250	47	39
500	80	69
1000	94	83
2000	93	95

Uses—actual and potential

Sound absorption—Metal fibers show considerable promise as high temperature, corrosion resistant sound absorbers. Work done by Armour physicists has shown that stainless steel fiber test specimens compare favorably with unbonded Fiberglas. Some of the data developed are shown in Table 2. Tests were made at room temperature but similar results were obtained up to 1500 F.

Vibration damping—Fiber metal

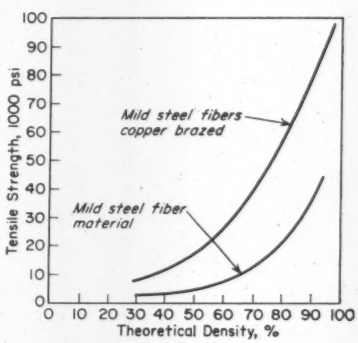


Fig 2—*Tensile strength vs density of mild steel fibers.*

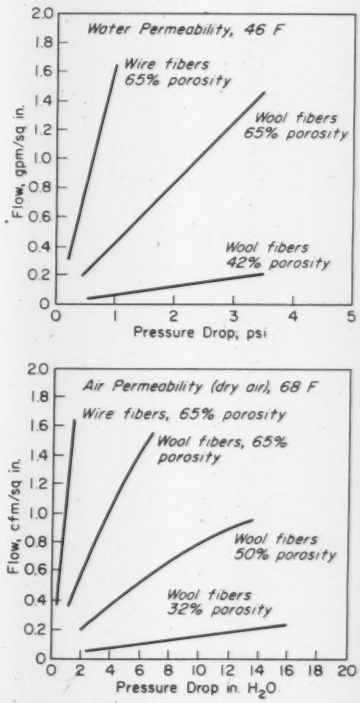


Fig 3—*Permeability to air and water of stainless steel fiber shells.*

materials can absorb mechanical vibrations. That is, they have a high internal damping capacity. Tests showed that stainless steel sheets 20 and 24% dense had resonant magnification factors of 4.6 and 13, respectively, whereas 1100 aluminum sheet, of equivalent weight per unit area, had a magnification factor of 27.

Fiber reinforcing—Early data show that the tensile strength of pure magnesium in the as-cast condition can be greatly increased by reinforcing with a steel fiber shell (see Table 3). The magnesium can either be cast around the fiber shell or the shell can be dipped into a magnesium bath.

Metal-fiber-reinforced plastics have better impact strength, fatigue strength and wear resistance than glass-reinforced plastics and, in addition, are good conductors of heat and electricity. The improved thermal conductivity of the metal fiber skeleton helps to increase the rate of polymerization of the plastics body. The increase in strength can be seen in Table 4. Depending on the type of metal fiber shell used, and the percent by volume of the shell, a metal-fiber-reinforced plastic may show an increase in rupture strength of almost 800%, and an increase in modulus of elasticity of 3400%. An increase in abrasion resistance is demonstrated by the "Epoxy Alloy" (M/DE, Mar '58, p 145) used as a tool and die material for medium-run production dies.

It is also believed that incorporating a uniform, fine metal skeleton in a refractory ceramic can improve its strength, shock resistance and thermal properties. Strength improvements analogous to those found in prestressed reinforced concrete are visualized.

The future—The list of potential applications is extensive: reinforced elastomers, low density structural materials, porous self-lubricating bearing materials, porous metal for aerodynamic applications (boundary layer control and transpirational cooling), reinforced friction materials (improved brake linings), metal flame barriers, gas mixers or diffusers, and many others. Fiber metallurgy has developed a new engineering material which should make an impact on many industries.

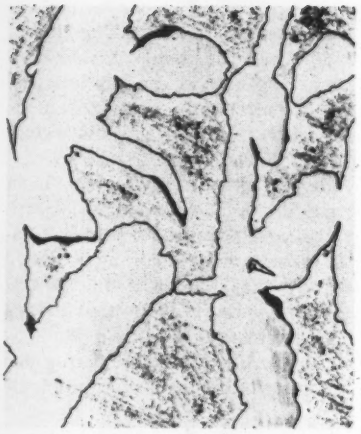
TABLE 3—STRENGTH OF AS-CAST MAGNESIUM REINFORCED WITH STEEL FIBER BODY

% Steel Fiber (by vol)	Ten Str, psi	Ten Str / Density
0	7,600	4,370
4.5	10,700	5,350
9	18,950	8,430
27	39,870	12,100

TABLE 4—METAL FIBER REINFORCEMENT OF EPOXY RESINS

Metal Fiber	Volume, %	Impact Strength ft-lb/in. notch	Flexure	
			Modulus of Rupture, psi	Modulus of Elasticity, 10^6 psi
None		1	8,500	0.44
Aluminum	25[a]	3	10,000	0.7
	50[a]	6	12,500	0.9
	75[a]	8	17,500	2.1
430 Stainless Steel	25[a]	4	12,500	1.6
	50[a]	6	18,000	1.8
	75[a]	8	25,000	2.2
	83[b]	11.5	64,300	17.0
Mild Steel	50[c]	5	59,900	16.3
Molybdenum	30[a]	32	62,000	4.3

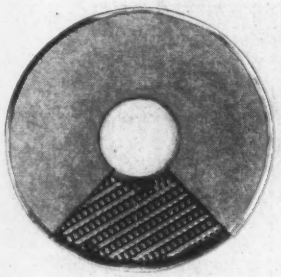
[a]Unbonded fibers. [b]Bonded (sintered) fibers.
[c]Unbonded, very long fibers perpendicular to applied stress.



Stainless fiber shell *(type 430) infiltrated with magnesium. Note continuous bonding of stainless fibers. Unetched, 150X.*

Editor's Note

The Purolator Co. is now using metal fiber filters for high temperature filtration of corrosive materials. The filter replaces a powder metallurgy product which was difficult to fabricate because it was relatively brittle. The pliability of the metal fiber sheets greatly exceeded that of the powder metallurgy part, enabling the company to roll a seal around the periphery of the unit and still maintain a better-than-10μ seal. In addition, greater permeability—on the order of 110%—is achieved by using metallic fiber filters. This application won a citation in M/DE's third annual competition for Best Use of Materials in Product Design (M/DE, May '59, p 138).



Filter *partly cut away to show fiber metallurgy structure.*

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The award-winning entries will be published in the May Design Engineering Show Issue of **Materials in Design Engineering.** Some non-winning entries will also be published in subsequent issues and paid for at the usual rate.

MATERIALS
IN
DESIGN
ENGINEERING

4th ANNUAL AWARDS COMPETITION

To encourage sound, imaginative and progressive use of engineering materials in industrial and consumer products, **Materials in Design Engineering** each year sponsors an Awards Competition for Best Use of Materials in Product Design. The entries in these Annual Competitions are reviewed by a distinguished board of judges.

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1

• Simply select your best work of 1959

You can enter any part or product which you worked on, provided that 1) the design was completed during 1959, or 2) the product went into production during 1959. An entry may be either a new product or a redesigned product that demonstrates sound, imaginative and progressive use of engineering materials. Engineering materials are defined as metals, nonmetallics, finishes and coatings, and material forms (such as castings, forgings, moldings, etc.). The product may be a complete assembly, a subassembly, a single part or a component.

2

• Prepare your entry—it's easy

You need not write up your entry in the form of an article. Entries will not be judged for literary quality. See back page of this folder for details on the information that must be submitted with each entry.

3

• Send in your entry by February 1

Entries must be mailed no later than February 1, 1960. Mail all entries to

Awards Editor { **Materials in Design Engineering**
430 Park Avenue, New York 22, New York

ENTRY FORM ➔

ENTRY FORM

Materials in Design Engineering

4th ANNUAL AWARDS COMPETITION

for the Best Use of Materials in Product Design

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IMPORTANT: OBSERVE THESE SIMPLE RULES CAREFULLY!

Preparation of Entries

1. The following information must be provided with each entry in order to allow the judges to make competent decisions:

a. A detailed description of the product including photographs or drawings. If the entry is a redesign, provide before and after illustrations if possible.

b. A description of requirements in service and/or fabrication that must be met by the product and the material.

c. A description of the previously used materials (if entry is a redesign).

d. A description of the material or materials selected for the product entry.

e. An explanation of why the material or materials were selected for the product. Describe the advantages or benefits gained through the choice Back them up with evidence — facts, data, charts tables on performance, quality or cost.

In general, entries should show that the materials selected for the product —

Resulted in improved performance and/or lower costs or

Best met the design and service requirements.

Here are a few specific ways in which a product can benefit from intelligent materials selection:

- Long service life
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- Less material required
- Improved appearance
- Permitted a new design
- Reduced production costs
- Improved service performance
- Reduced scrap
- Reduced or eliminated maintenance
- Permitted lower cost design
- Allowed greater design flexibility
- Simplified production and fabrication

Remember! The more detailed and documented your entry is, the more consideration it will receive from the judges.

2. Entries or portions of entries will not be returned unless requested. Entries should not include valuable papers or other material which must be returned, because there is always some danger of loss or mutilation. Whenever possible, photostats, photographs or other copies of such materials should be used instead.

3. All entries must be postmarked not later than **February 1, 1960**

Materials in Design Engineering plans to publish articles on the winning entries and reserves the right to publish articles based on entries not winning awards. The judges reserve the right to withhold awards at their discretion.

NOTE: Please observe the rules given above. Use a separate blank for each entry; additional entry blanks available on request. Attach entry blank below, or its equivalent, to your entry and mail to:

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Name _____ Title _____

Name(s) of person(s), group or organization who would receive award _____

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Street address _____ City _____ State _____

Name or brief description of product being entered _____

_____

Was design (or redesign) of entry either completed or placed in production during 1959? _____

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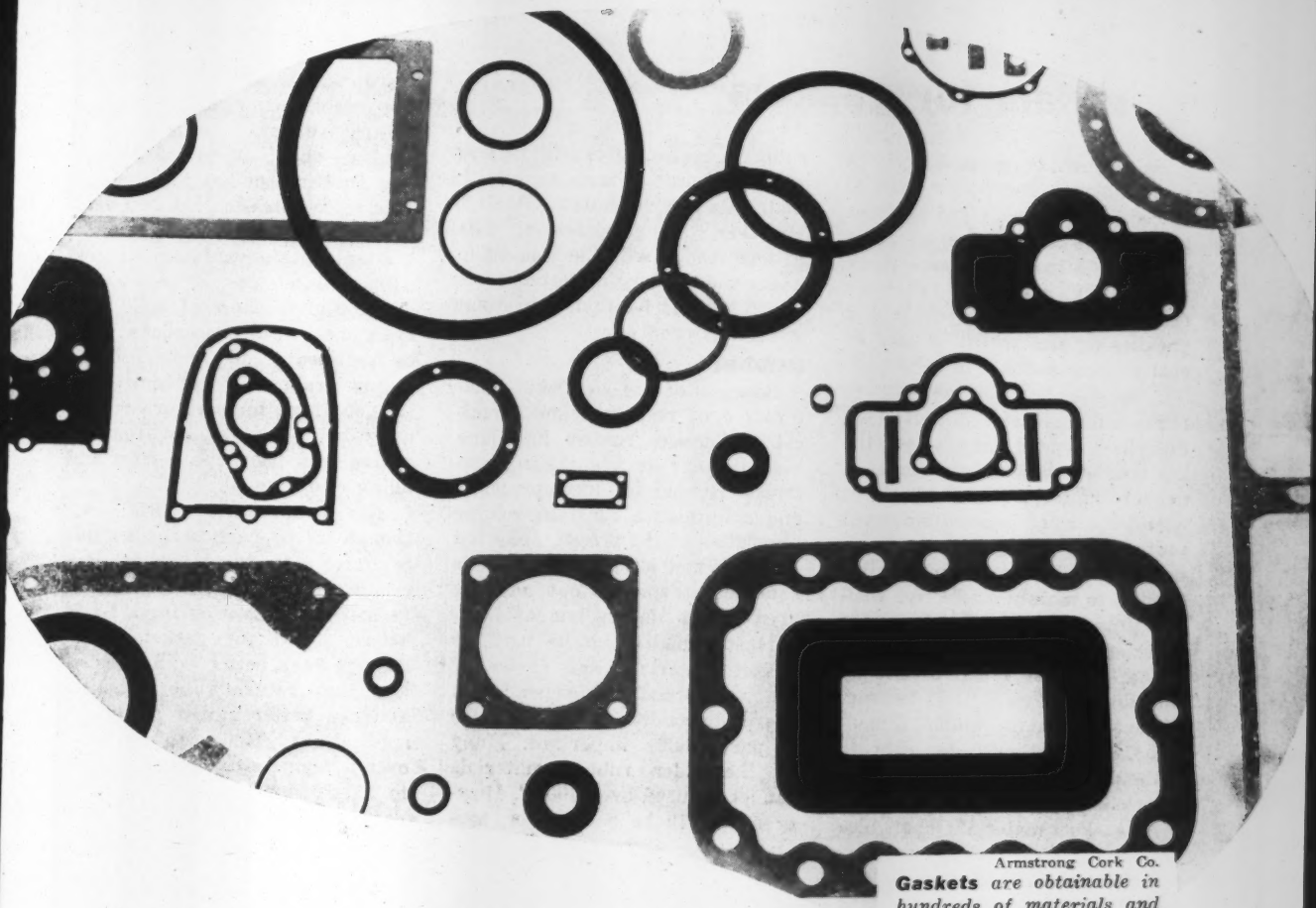


Armstrong Cork Co.
Gaskets *are obtainable in hundreds of materials and shapes to meet any static sealing application.*

Materials for Gaskets, Packings and Seals

by **Robert J. Fabian,** *Associate Editor, Materials in Design Engineering*

Materials
in Design Engineering

Manual No. 165
December 1959

Hundreds of materials and composites are available for sealing fluids under static or dynamic conditions. This survey tells you:

- *What materials and forms are available*
- *What fluids they can withstand*
- *How well they resist heat*
- *How their mechanical properties compare*

Materials for gaskets

By definition a gasket is a somewhat resilient part that is placed between two rigid surfaces to make a leakproof seal. It is used in static applications where no relative motion of surfaces occurs and thus differs from a packing or seal which is used to seal moving parts.

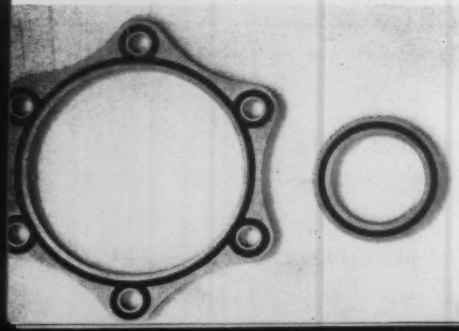
A gasket plays a key role in many machines, and its usefulness and life depend largely on the material of which it is made. A gasket material must have a combination of many important properties. Most important, it must be resilient and compressible enough to maintain effective sealing pressure without taking too much of a permanent set. In addition, it must resist attack by the liquids or gases it is sealing, it must maintain stable dimensions, and it must be able to withstand any temperature extremes.

A gasket material must also be compatible with the flange surfaces with which it mates. Compatibility is not usually important when using nonmetallic gaskets but must be considered when using metal gaskets, as the contact of unlike metals can cause galvanic corrosion.

An extremely wide range of gasket materials have been developed to meet the above requirements. In addition to such basic materials as rubber, cork and asbestos, the designer has a choice from a wide variety of composite materials such as rubber-cork, rubber-asbestos, rubber-fabric and many others. These composite materials are difficult to classify. However, for purposes of this article they will be classified under the primary materials from which they derive their important gasketing properties.

Rubber *gaskets can be formulated to seal gases and many chemicals at temperatures up to 600 F. Gaskets shown here are used in fuel system of new Convair 880 jet transport.*

Stillman Rubber Co.



Rubber

Because of its desirable combination of resiliency and chemical resistance, rubber has long been popular as a gasketing material. Rubber is incompressible and maintains a constant volume regardless of the pressure exerted on it. When a rubber gasket is squeezed it spreads out and the area of the gasket increases.

Most rubbers can be used as gasket materials, and choice of the right material depends on operating conditions. Temperature is particularly important. Many of the older rubber materials cannot be used over 300 F. However, as will be noted later, several of the newer materials have outstanding high temperature properties.

The designer should keep in mind that certain hydrocarbons, especially petroleum oils, are detrimental to some rubber gaskets. However, many rubbers are available that have outstanding resistance to these media.

Following is a rundown and comparison of the basic rubber materials available for gasketing. Keep in mind that the materials described here are basic rubber materials, not composites. They are available in a variety of plain or fabric-reinforced shapes such as flat gaskets, rings, and an unlimited variety of molded shapes. Many types are available in a wide hardness range, depending on the bolt loads required and the surface condition of the flanges.

Natural rubber—The main advantages of natural rubber gaskets are their high resilience and imperviousness to water. Depending on the concentrations encountered, they also have a fair to good resistance to acids and alkalis. The usable temperature range of natural rubber is comparatively narrow—about –65 to 225 F. Natural rubber also has high resistance to compression set and very good cold flow characteristics.

Despite its advantages, natural rubber gaskets are not popular today, mainly because of their poor resistance to hydrocarbons such as petroleum oils and gasoline. Natural rubber is also limited by its poor high temperature resistance, brittleness at low temperatures, and poor weathering and aging properties.

Styrene-butadiene (SBR)—Although its properties are similar to those of natural rubber, styrene-butadiene copolymer rubber (sometimes known as Buna S) is better suited for gaskets. SBR gaskets have better water resistance than natural rubber gaskets and are better suited for moist applications. They can be used over a temperature range of –70 to 250 F. The gaskets have fair to good resistance to acids and alkalis. They are unsuited for use with gasoline, oils and solvents.

Butyl—The properties of butyl (or IIR) rubber gaskets are quite similar to those of natural rubber and SBR gaskets. Their usable temperature range is –65 to 300 F. Butyl gaskets have very good resistance to water, alkalis and many acids (especially nitric). However, they have very poor resistance to oils and gasoline. They also have poor resistance to most solvents except oxygenated types.

Nitrile—Nitrile rubber (sometimes known as NBR or Buna N) gaskets are made from a copolymer of acrylonitrile and butadiene. Their temperature range is about the same as that of natural rubber, –65 to 300 F. They have very good resistance to water and, unlike the gasket materials described above, generally have excellent resistance to oils and gasoline. The resistance of nitrile rubber gaskets to acids and alkalis ranges from fair to good, depending on the concentrations used. Their resistance to aromatic and aliphatic hydrocarbon sol-

vents varies from fair to excellent. The gaskets have poor resistance to oxygenated solvents and very poor resistance to halogenated solvents.

Polysulfide — The outstanding advantage of polysulfide gaskets is their excellent resistance to aliphatic and aromatic hydrocarbon solvents. They have excellent resistance to oils and gasoline, very good water resistance, good resistance to alkalis, and fair resistance to acids. They generally have lower resilience and resistance to compression set, and poorer mechanical properties, than other rubber and elastomeric gaskets. Some have a very narrow temperature range, and cannot be used over 150 F.

Neoprene — Neoprene gaskets are especially noted for their excellent mechanical properties and good resistance to non-aromatic petroleum products, fatty oils and solvents (except those of the aromatic, chlorinated or ketone types). They have good resistance to water and alkalis and fair resistance to acids. Usable temperature range is –50 to 250 F. The gaskets are available in sponge as well as solid forms.

Silicone—The main advantage of silicone rubber gaskets is that they can be used at considerably higher and lower temperatures than other gasket materials—from –120 to 600 F. The gaskets are particularly recommended where dry heat is encountered as they only have fair water resistance. Also, they should not be used with steam at high pressure. Their resistance to acids and alkalis ranges from fair to good, depending on concentration. Resistance to solvents and oils is poor, although improved resistance is obtainable with fluorosilicone rubber.

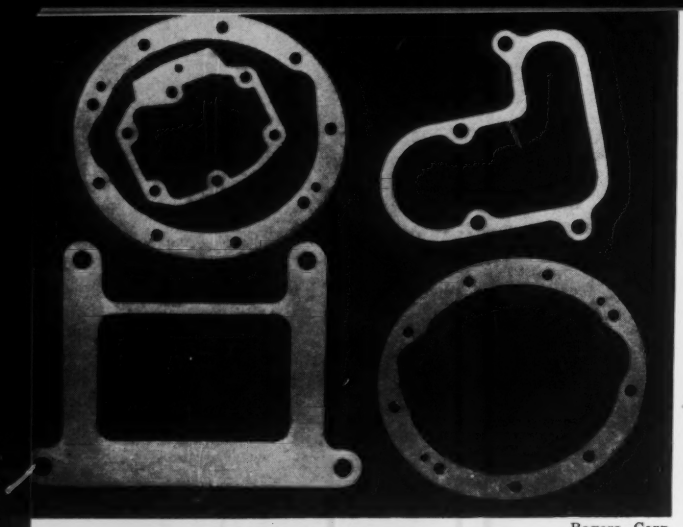
Silicone rubber has poor resistance to gasoline, low aniline point oil, and oxygenated and halogenated solvents. The material can be cellular sponged to produce a uniform structure.

Polyacrylate—Polyacrylate rubber gaskets are noted for resistance to high temperatures—up to 450 F. Their low temperature properties are relatively poor and they cannot be used below –10 F. They have poor resistance to water, alkalis, some acids, and oxygenated and halogenated solvents. They have good resistance

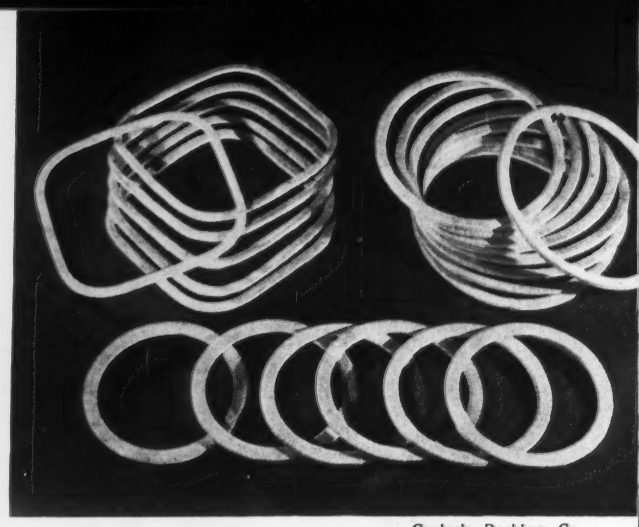
A SUMMARY OF GASKET MATERIALS

Material ↓	Max Service Temp, F	Important Properties
RUBBER (Straight)		
Natural	225	Good mechanical properties. Impervious to water. Fair to good resistance to acids, alkalis. Poor resistance to oils, gasoline. Poor weathering, aging properties
Styrene-Butadiene (SBR)	250	Better water resistance than natural rubber. Fair to good resistance to acids, alkalis. Unsuitable with gasoline, oils and solvents
Butyl	300	Very good resistance to water, alkalis, many acids. Poor resistance to oils, gasoline, most solvents (except oxygenated)
Nitrile	300	Very good water resistance. Excellent resistance to oils, gasoline. Fair to good resistance to acids, alkalis
Polysulfide	150	Excellent resistance to oils, gasoline, aliphatic and aromatic hydrocarbon solvents. Very good water resistance, good alkali resistance, fair acid resistance. Poor mechanical properties
Neoprene	250	Excellent mechanical properties. Good resistance to non-aromatic petroleum, fatty oils, solvents (except aromatic, chlorinated or ketone types). Good water and alkali resistance. Fair acid resistance
Silicone	600	Excellent heat resistance. Fair water resistance; poor resistance to steam at high pressures. Fair to good acid, alkali resistance. Poor (except fluorosilicone rubber) resistance to oils, solvents
Acrylic	450	Good heat resistance but poor cold resistance. Good resistance to oils, aliphatic and aromatic hydrocarbons. Poor resistance to water, alkalis, some acids
Hypalon	250	Excellent resistance to oxidizing chemicals, ozone, weathering. Relatively good resistance to oils, grease. Poor resistance to aromatic or chlorinated hydrocarbons. Good mechanical properties
Viton Fluoroelastomer	450	Can be used at high temperatures with many fuels, lubricants, hydraulic fluids, solvents. Highly resistant to ozone, weathering. Good mechanical properties
ASBESTOS		
Compressed Asbestos-Rubber Sheet	To 700	Large number of combinations available; properties vary widely depending on materials used. See text
Asbestos-Rubber Woven Sheet	To 250	Same as above
Asbestos-Rubber (beater addition process)	400	Same as above
Asbestos Composites	To 1000	Same as above
Asbestos-TFE	500	Combines heat resistance and sealing properties of asbestos with chemical resistance of TFE

table continues on p 115



Rogers Corp.



Garlock Packing Co.

Asbestos *can be used in many ways to obtain specific properties. Gaskets at left are made by beater addition method from a blend of asbestos fibers and SBR rubber. Gaskets at right are made of wire-inserted asbestos cloth (treated with a heat-resistant rubber cement) which is folded, formed and pressed into shape.*

to oils, and to aliphatic and aromatic hydrocarbons.

Hypalon—Hypalon (chlorosulfonated polyethylene) gaskets are primarily noted for their excellent resistance to oxidizing chemicals, ozone and weathering. They also have relatively good resistance to oils and greases. They are not recommended for continuous contact with aromatic or chlorinated hydrocarbons. Hypalon gaskets have good mechanical properties but do not have very good heat resistance. They can be used continuously at 250 F and intermittently at 350 F. They are usable down to –40 to –80 F.

Viton fluoroelastomer — Viton gaskets combine excellent resistance to high temperatures and a wide variety of fluids. They can be used at temperatures of 500 F and up with many fuels, lubricants, hydraulic fluids and solvents. They also have good mechanical properties and are highly resistant to ozone and weathering. Their low temperature properties are not outstanding but are usually adequate for most uses.

Asbestos

The most important property of asbestos gaskets is their high heat resistance. Since asbestos is an inorganic material, it will withstand higher temperatures than organic gasket materials such as rubber, plastics, cork and vegetable fibers.

The two most common types of asbestos used in gaskets are white asbestos and blue asbestos. In general, white asbestos alone can be used in contact with weak acids and many alkali solutions, but it has poor resistance to strong mineral acids. Blue asbestos has much better acid resistance than white asbestos but is more expensive. Aside from chemical resistance, the mechanical and high temperature properties of the two grades are approximately equal.

Asbestos can be used alone as a gasket material but is usually combined with other materials to improve its mechanical properties and chemical resistance. These additive materials tend to lower heat resistance, but their use is more than justified in most applications. Unlike rubber, asbestos is compressible.

Following is a summary of the most important types of asbestos gaskets available:

Compressed asbestos - rubber sheet—Asbestos fibers can be combined with many different rubber compounds and vulcanized under high pressure to produce a homogeneous flat gasket sheet. A typical compound may contain 80% asbestos and 20% rubber binder. This binder may be a natural rubber, neoprene, SBR or other synthetic rubber. End properties of the various compounds depend largely on the kind and amount of rubber used. Some types perform well against steam, air and gases at temperatures up to 700 F, but do not resist hot oil, organic solvents or strong mineral acids. On the other hand, a compound made up of white asbestos and neoprene can be formulated with high resistance against oil and solvents up to 300 F. Still other types (notably those containing blue asbestos) can be used with hot and cold mineral acids and organic solvents. Thus, depending on the asbestos-rubber combination used, gaskets can be made to resist saturated and superheated steam, air, gas, oils, acids, alkalis, solvents and many other chemical materials.

Asbestos-rubber woven sheet—These materials consist of woven, long fiber asbestos yarn impregnated with various cements or coated with rubber. They are frequently reinforced with wire. In general, they can be formulated to have the same range of chemical and heat resistance as the compressed and vulcanized materials described above. However, their added flexibility is useful in many applications, particularly in sealing corroded or misaligned surfaces.

Other asbestos-rubber combinations—In addition to the compressed and woven materials described above, asbestos and rub-

ber can be processed by a beater saturation process similar to that used in making paper. In this process the asbestos fibers are thoroughly coated and sealed with the rubber binder material to produce a homogeneous gasket material with uniform properties. Following is a summary of the important asbestos-rubber combinations made by the beater saturation process:

1. Asbestos-Viton fluoroelastomer: Good performance to 400 F. Resists most new aircraft and missile lubricants and hydraulic fluids.

2. Asbestos-neoprene: Recommended for use in oil, gasoline and freon systems and in water systems with antifreeze.

3. Asbestos-nitrile rubber: Recommended for use against oil, gasoline, and aromatic hydrocarbons.

4. Asbestos-acrylic binder: Recommended for dry heat applications. Has good flexibility after heat aging. Suitable for use against oil or gasoline.

5. Asbestos-SBR: Recommended for use in water (with or without antifreeze), steam and oil.

Asbestos composites—As noted in later sections, asbestos is used as a secondary material with TFE or metals in flat composite gaskets. In addition, asbestos can be used as the primary material in composite gaskets, which are usually made in tape form and are quite flexible. These tapes (sometimes called tadpole tapes) consist of an outer layer of asbestos and an inner core of another gasketing material. They are designed for use on flanges where limited bolting force is available and where the gasket must conform to uneven surfaces.

A wide variety of core materials can be used inside the asbestos layer, depending on the amount of heat and chemical resistance needed. These materials include acrylic rubber, silicone rubber and Inconel mesh (with or without a metal foil covering). In addition, the outer asbestos layer can be reinforced with wire or impregnated with TFE resins or rubber compounds. Space does not permit analysis of the many combinations available. However, properties are readily obtainable from gasket suppliers.

Asbestos-TFE fluorocarbon—This gasket material consists of either white or blue asbestos cloth or tape impregnated with TFE resins (roughly 35%). The gaskets combine the heat resistance and sealing properties of asbestos with the excellent chemical resistance of TFE resins.

A SUMMARY OF GASKET MATERIALS (continued)

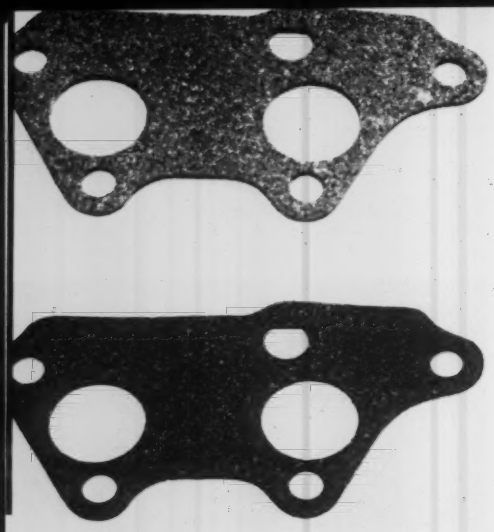
Material ↓	Max Service Temp, F	Important Properties
CORK COMPOSITIONS	250	Low cost. Truly compressible materials which permit substantial deflections with negligible side flow. Conform well to irregular surfaces. High resistance to oils; good resistance to water, many chemicals. Should not be used with inorganic acids, alkalis, oxidizing solutions, live steam
CORK-RUBBER	300	Controlled compressibility properties. Good conformability, fatigue resistance. Chemical resistance depends on kind of rubber used. See text
PLASTICS		
TFE (solid)	500	Excellent resistance to almost all chemicals and solvents. Good heat resistance; exceptionally good low temperature properties. Relatively low compressibility and resilience
TFE (filled)	To 500	Selectively improved mechanical and physical properties. However, fillers may lower resistance to specific chemicals
TFE Composites	To 500	Chemical and heat resistance comparable to solid TFE. Inner gasket material provides better resiliency and deformability
CFE	350	Higher cost than TFE. Better chemical resistance than most other gasket materials, although not quite as good as TFE
Vinyl	212	Good compressibility, resiliency. Resistant to water, oils, gasoline, and many acids and alkalis. Relatively narrow temperature range
Polyethylene	150	Resists most solvents. Poor heat resistance
PLANT FIBER		
Neoprene-Impregnated Wood Fiber	175	Nonporous; recommended for glycol, oil and gasoline to 175 F
GRS-Bonded Cotton	230	Good water resistance
Nitrile Rubber-Cellulose Fiber	—	Resists oil at high temperatures
Vegetable Fiber-Glue Binder	212	Resists oil and water to 212 F
VULCANIZED FIBRE	—	Low cost, good mechanical properties. Resists gasoline, oils, greases, waxes, many solvents

table continues on p 117

Cork

Because of its low cost and compressibility, cork is one of the most widely used gasket materials. Cork gaskets are molded from raw cork which has been ground, mixed and impregnated with suitable binders. Density ranges from 14 to 28 lb per cu ft, depending on the size of the particles and other factors.

As pointed out in a later section, cork can be combined with rubber to produce a variety of composite gasket materials. How-



Armstrong Cork Co.

Cork *composition gaskets can be made to meet a wide range of requirements.* **Cork composition (top)** *gasket made up almost entirely of cork granules and gelatin binder is truly compressible and permits substantial deflection with negligible side flow.* **Cork-rubber (above)** *gasket combines the advantages of cork and rubber, has controlled compressibility, and can be made in various combinations to meet many conditions.* **Ground cork, cellulose or asbestos fibers and rubber (below)** *are combined in beater saturation process to produce composite gasket materials with wide range of properties.*

ever, the "pure" cork compositions are bonded with a protein or synthetic resin binder. In general, protein-bonded cork gaskets are cheaper than resin-bonded gaskets but do not have as good environmental resistance. Resin-bonded gaskets are more resistant to outdoor environments and to water, fungus, chemicals, oils and other media.

Cork is a truly compressible material. Thus, cork gaskets permit substantial deflections with negligible side flow and are well suited for confined applications where no relief for side flow can be provided. In addition, the softness of cork helps to compensate for any flange irregularities. The cushioning effect of cork is also valuable in sealing easily damaged surfaces such as glass or ceramics.

Cork compositions have excellent resistance to oils and are the cheapest oil seal materials available for the normal ranges of temperature and pressure. For example, they are used in overhead valve engines as a seal between the valve cover and the cylinder block. In general, cork compositions can be used where sustained temperatures at the gasket line are below 250 F. They should not be used to seal inorganic acids, alkalis, oxidizing solutions or live steam.

Cork composition gaskets become essentially impervious to liquids at relatively low flange pressures—400 to 1200 psi, depending on density. They will seal at loads as high as 4000 psi or higher without extrusion or rupture. In general, they cannot be used to seal air or other gases. The gaskets may have a tendency to stick to some flange materials; however, this condition can be eliminated by using special surface coatings.

Cork-rubber

Cork-rubber gaskets provide a transition between compressible straight cork gaskets and incompressible rubber gaskets. The controlled compressibility of cork-rubber gaskets is useful in compensating for tolerance variations and in applications where the gasket is contained without relief. The amount of compressibility is controllable in varying degrees from soft to hard by varying the cork-rubber ratio (a typical ratio being 50:50). Compressibility and density can also be varied by sponging the materials. Because of their elastomeric properties, all cork-rubber gaskets have very good comformability and fatigue resistance.

The resistance of a cork-rubber gasket to a particular liquid is generally equivalent to the resistance of the rubber base. However, this rough rule does not hold true in the case of a fluid that might attack the cork particles. In all cases the effect of the contained liquid can be minimized by using proper flange loads. Unlike the straight cork compositions, cork-rubber gaskets generally have good sealing properties against gases.

Following are the major types of cork-rubber gaskets available:

Cork-neoprene rubber gaskets are normally used with lubricating oils and for general purposes where some swell is desired or can be tolerated. These gaskets can be obtained in solid form as well as in a highly compressible sponge form which resists fatigue and is useful under low bolt pressures.

Cork-butyl rubber gaskets have good resistance to oils, gasoline and aromatic solvents. They are available in a wide range of densities and hardnesses and can be made in sponge form.

Cork-butyl rubber gaskets have high resistance to noninflammable hydraulic fluids and high temperature lubricants. They also have excellent low temperature properties. Sponge cork-butyl gaskets with high compressibility are available. These gaskets have excellent resistance to ozone and moisture and are well suited as automotive lamp gaskets.

Cork-SBR gaskets are inexpensive but have limited solvent resistance. They are available in sponged form and are used in automotive tail lights.

Cork-silicone rubber gaskets are designed mainly for high temperature applications. Most cork-rubber gaskets are limited to use below 300 F, but cork-silicone gaskets can go higher.

Cork-Viton fluoroelastomer gaskets are intended for use where resistance to high temperatures, chemicals, or both is needed. These composite gaskets are new and specific properties should be checked with the material supplier.

Special cork-rubber materials, recently announced, have a differ-

ent mechanical structure than the conventional impregnated cork-rubber materials described above. These materials (called Uniphase) consist of a continuous rubber binder that completely surrounds the cork particles and protects them from attack. In addition to having high chemical resistance, the materials are impermeable, have high conformability, and can be sealed over a wide range of flange pressures—from 100 to over 4000 psi. They are not recommended for use over 250 F.

TFE plastic

TFE fluorocarbon resins have proved to be extremely versatile materials for gaskets (and also for seals and packings, as will be noted later). Although commonly used alone, TFE can be combined with various other nonmetallic and metallic materials to make a composite envelope gasket. Also, various fillers can be added to the material to produce specific end properties.

General properties—The popularity of TFE gaskets stems largely from their high chemical resistance. TFE gaskets are resistant to most chemicals and solvents with the exception of alkali metals under certain conditions. At some elevated temperatures and pressures, halogens and certain halogenated solvents may affect TFE gaskets. But, in general, they have the best all-around chemical resistance of all gasket materials.

The mechanical properties of solid TFE gaskets are comparable to those of high grade, rubber-bonded, compressed asbestos gaskets. However, the compressibility and resiliency of TFE gaskets are not as high as in pure rubber gaskets. TFE gaskets have been reported to be subject to cold flow. However, tests show that the tendency to cold flow is not excessive and is encountered only during the first few hours after the load is applied. Equilibrium is reached under any given pressure and temperature, and no further change will occur unless the load or temperature is changed. In some cases the effects of changing load or temperature can be lessened by using a suitable filler.

A SUMMARY OF GASKET MATERIALS (continued)

Material ↓	Max Service Temp, F	Important Properties
INORGANIC FIBERS	To 2200 F	Excellent heat resistance, poor mechanical properties
FELT		
Pure Felt	—	Resilient, compressible and strong, but not impermeable. Resists medium strength mineral acids and dilute mineral solutions if not intermittently dried. Resists oils, greases, waxes, most solvents. Damaged by alkalis
TFE-Impregnated	300	Good chemical and heat resistance
Petrolatum or Paraffin-Impregnated	—	High water repellency
Rubber-Impregnated	—	Many combinations available; properties vary widely depending on materials used. See text
METAL		
Lead	500	Good chemical resistance. Best conformability of metal gaskets
Tin	—	Good resistance to neutral solutions. Attacked by acids, alkalis
Aluminum	800	High corrosion resistance. Slightly attacked by strong acids, alkalis
Copper, Brass	—	Good corrosion resistance at moderate temperatures
Nickel	1400	High corrosion resistance
Monel	1500	High corrosion resistance. Good against most acids and alkalis, but attacked by strong hydrochloric and strong oxidizing acids
Inconel	2000	Excellent heat, oxidation resistance
Stainless Steel	—	High corrosion resistance. Properties depend on type used
METAL COMPOSITES	—	Many combinations available; properties vary widely depending on materials used. See text
LEATHER	220	Low cost. Limited chemical and heat resistance. Not recommended against pressurized steam, acid or alkali solutions
GLASS FABRIC	—	High strength and heat resistance. Can be impregnated with TFE for high chemical resistance

TFE gaskets can be used at temperatures up to 500 F and pressures up to about 5000 psi in normally confined service (pressures as high as 30,000 psi can be tolerated with special designs and tolerances). For normal unconfined joints, TFE gaskets will satisfactorily withstand pressures of about 1000 psi at 500 F. TFE gaskets also have excellent low temperature properties and have successfully been used with liquid oxygen at –298 F and liquid nitrogen at –320 F.

Solid gaskets—Solid TFE gaskets can be made by die cutting gaskets from molded sheet, by slicing the ends from a molded cylinder, by molding directly from powder, or by pressure-fusing segments cut from a molded sheet. The gaskets are generally made in thicknesses of 0.03 to 0.125 in.

It is recommended that the thinnest gasket possible be used.

At high stresses (8000 to 10,000 psi) gaskets thicker than 1/8 in. may be subject to cold flow. This factor may be important at elevated temperatures where thermal expansion can increase gasket stresses.

Filled TFE—A variety of filler materials can be added to TFE to improve the mechanical and physical properties of gaskets. Typical of these filler materials are carbon, glass fiber, ceramics, talc, calcium fluoride, and metals such as lead and bronze. These fillers help to improve such properties as resistance to deformation, dimensional stability, wear resistance, stiffness, compressive strength, hardness and thermal conductivity.

Choice of the best filler to use should be worked out with the gasket supplier when improved properties are needed. Keep in mind that some fillers may not be compatible with the media to be sealed. Glass fibers, for example, should not be used in contact with hydrofluoric acid, and carbon should not be used with liquid oxygen.

Envelope gaskets—TFE envelope gaskets consist of an outer jacket of TFE and an inner filler layer(s) of an ordinary gasketing material (Fig 1). The outer jacket of TFE provides high chemical resistance; the inner filler gasket material provides resiliency and deformability. Envelope gaskets are particularly effective where it is difficult to seal solid TFE gaskets, and for sealing delicate glass or porcelain flanges.

A large number of filler gasket layers can be used inside the TFE gasket to meet various operating conditions. The following are typical:

- A 1/16 to 1/8 in. filler of compressed asbestos can be used where not much deformability is needed.
- A combination filler of compressed asbestos and soft laminated woven asbestos cloth can be used for maximum resiliency and deformability.
- Rubber and rubber-steel combinations can be used, and cork fillers are available with or without rubber impregnations.
- For very high temperatures and pressures an inner filler of corrugated stainless steel can be used inside the TFE jacket. For glass-lined steel connections with low bolt loads the steel can be sandwiched between woven asbestos cloth.

Other plastics

In addition to TFE, a number of other plastics can be used in gaskets, including CFE fluorocarbons, polyethylenes, vinyls, phenolics, ureas and melamines. Of these materials, CFE is probably most used. The vinyls are mainly available in elastomeric form where high compressibility is needed. Polyethylenes are used in a few applications. The phenolics, ureas and melamines are principally used as impregnants and binders to improve the properties of fibrous and granular gasket materials.

CFE fluorocarbon resins, mainly because of their higher cost, are not nearly so widely used for gaskets as TFE resins. However, CFE can be advantageous in some specialized applications. (For a comparison of TFE and CFE see "Selection and Design of Fluorocarbon Plastics," *Materials & Methods*, June '57, p 129.)

CFE has higher mechanical strength and rigidity than TFE. Although not as chemical resistant as TFE, CFE is inert to most corrosive chemicals and is highly resistant to most organic solvents. CFE gaskets can be used over a temperature range of –320 to 390 F.

In general, CFE is not used in as wide a variety of composite gaskets as TFE. Envelope-type CFE gaskets are not available. However, a limited number of fillers, notably glass fiber, can be used to improve mechanical properties.

Vinyl gaskets are mose closely allied to rubber gaskets than to the other plastic materials described above. Vinyl gaskets are elastomeric and thus similar to rubber in their compressibility and resiliency. They are resistant to water, oils, gasoline, and many acids and alkalis. In general, they are limited to continuous use at 110 F and can be used intermittently at 212 F.

Polyethylene has found limited use as a gasket material, mainly because of its poor high temperature properties. The material is limited to 140 or 150 F. Although resistant to most solvents, its chemical resistance is not nearly as good as that of fluorocarbon gaskets.

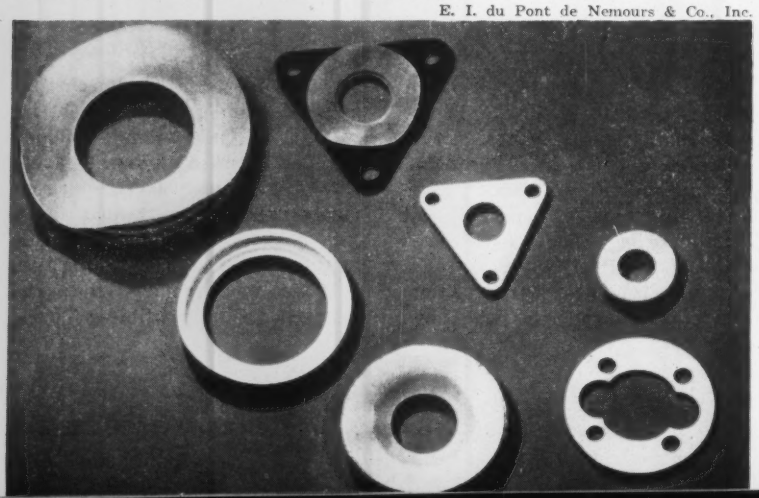
Plant fiber

Plant fiber gaskets are distinguished for their low cost and serviceability in many general purpose applications. In most cases the fibers are impregnated with a synthetic rubber to improve properties. Following is a brief rundown of available materials:

Neoprene-impregnated wood fi-

TFE fluorocarbon *gaskets have highest chemical resistance of all gasket materials. They are inert to all chemicals and solvents, except for molten alkali metals and fluorine gas at high temperatures and pressures.*

E. I. du Pont de Nemours & Co., Inc.



ber gaskets contain about 40% compounded neoprene. They form a nonporous seal and are recommended against glycol, oil and gasoline to 175 F. Typical uses include grease retainers, shock absorber cover seals, distributors and chain case covers.

GRS-bonded cotton fiber gaskets contain 20 to 25% rubber. The 20% rubber grade is used under moderate torque to seal water systems to 230 F. The 25% rubber grade is used for the same applications, but withstands higher torque and resists dimensional change during alternate wetting and drying.

Nitrile rubber–cellulose fiber blend gaskets withstand hydraulic pressures and the effects of oil at high temperatures. They are particularly recommended as an oil seal between finely machined surfaces.

Vegetable fiber–glue binder gaskets are designed to resist oils and water at temperatures to 212 F.

Vulcanized fibre

Vulcanized fibre gaskets are mainly noted for their low cost and good mechanical properties. Depending on the impregnant used, they can be made to resist such media as oils, greases, wax, acetone, gasoline, toluol, benzene, turpentine and kerosene.

Vulcanized fibre can also be coated to improve its properties. Fish paper grade coated with nitrile rubber, for example, compensates for any irregularities in flange surfaces and has high resistance to oils, gasoline, hydraulic fluids and refrigerants.

Inorganic fibers

Inorganic gaskets (and in some cases packings) made of quartz and aluminum silicate fibers are especially useful at high temperatures, particularly in aircraft and rocket applications. Quartz fiber gaskets can be used to about 1800 F, and aluminum silicate gaskets to about 2200 F. Because of their poor resistance to crushing special precautions have to be taken to protect the materials from mechanical damage.

Felt

Wool and synthetic fiber felts are very versatile gasket materials since their porous structure can be impregnated with many materials to improve their basic properties. The principal felts available for gasketing are:

Pure felt—Wool felt alone is resilient, compressible and strong, but not impermeable. Wool felt resists medium strength mineral acids and dilute mineral solutions, unless continuously saturated and intermittently dried. It is damaged by alkalis. Untreated, it will resist oils, greases, waxes and most solvents. Felts with substantial cotton content should not be subjected to mineral acid solutions.

TFE-impregnated felt — TFE-impregnated polyester felt gaskets are relatively new and have opened up many new applications for felt, particularly where high chemical and temperature resistance are needed.

TFE-impregnated felt gaskets can be used over a wide temperature range—from –100 to 300 F, and sometimes higher under some conditions. They will withstand attack by strong acids and bases, water, common fuels, lubricants, hydraulic fluids and solvents.

Rubber-impregnated felt—Felt can be impregnated with natural or synthetic rubber, or resin latices, to improve flexibility and increase strength in the presence of moisture, lubricants and various chemicals. The materials can be used for packings and seals as well as for gaskets.

Typical of the rubber impregnants that can be used with felts are natural rubber, SBR and neoprene. Selection of the proper rubber and its correct proportion depends on service conditions, e.g., the chemical resistance required and the amount of strengthening or resilience needed. Impregnant content can vary from 5 to 100% of solids.

Felt gaskets with extra high strength and stiffness can also be made of high pressure laminates. These laminates are formed from felt layers impregnated with natural or synthetic rubber or a resin. Strictly speaking, these high pressure laminates are not impregnated felts but should be considered as fiber-reinforced rubber or plastics materials.

Petrolatum or paraffin-impregnated felt—Felt gaskets impregnated with petrolatum, paraffin or wax have high water repellency. They are normally used for weather stripping and cowl stripping, and as gasketing materials

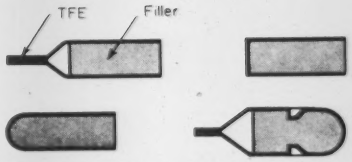


***Fig 1**—TFE envelope gaskets use outer layer of TFE for chemical resistance and inner filler for resiliency.*

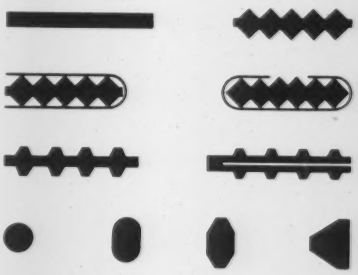


***Fig 2**—Metal ring gaskets are available in many cross sections to meet different mechanical and pressure requirements.*

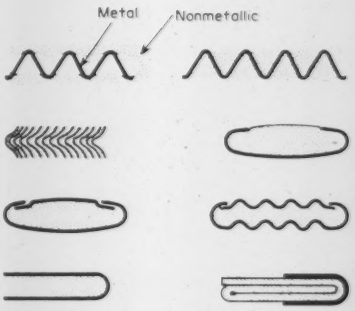
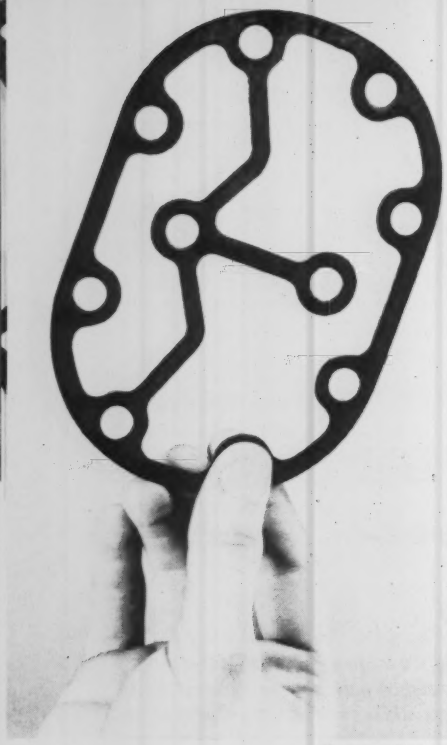


***Fig 3**—Composite metal-nonmetallic ring gaskets have better compressibility and resiliency than solid metal gaskets. Many other types are available in addition to those shown here.*



Taylor Fibre Co.

Vulcanized fibre *gaskets can be coated with rubber (in this case nitrile rubber) to improve their resistance to fluids and their conformability to irregular surfaces.*

Metal *gaskets are especially noted for their resistance to temperature extremes. Depending on metal used, gasket shown here provides leakproof seal at pressures over 10,000 psi and temperatures to 1200 F.*

Navan Products, Inc.

for plumbing fixtures.

Metal

Solid metal gaskets are designed for use in applications not suitable for nonmetallic gaskets. Such applications usually involve very high temperatures and/or troublesome corrosive media.

A wide range of gasket materials and configurations are available to the designer. Depending on mechanical and pressure requirements, gaskets can be obtained in such shapes as: plain solid, deeply corrugated, corrugated core with metal shell, solid metal with V-shaped grooves, grooved metal core with metal jacket, serrated, cross-ribbed, oval, and many others (Fig 2).

The degree of chemical and heat resistance obtainable with metal gaskets depends on the metal used. Here are the important gasket metals available and their properties. Most of these metals are available in the gasket forms described above.

Lead gaskets conform well to irregular flange surfaces because of their softness. They have good chemical resistance (especially to sulfuric acid) and are usable to 212 F.

Tin gaskets provide good performance in pure neutral solutions but are attacked by acids and alkalis. They can be used continuously up to 200 F.

Aluminum gaskets have high corrosion resistance. They provide good performance against sulfur-bearing gases and are usable to 800 F. They are slightly attacked by strong acids and alkalis, but this may not be objectionable.

Copper and brass gaskets have good corrosion resistance at moderate temperatures (up to 600 F).

Monel gaskets have high corrosion resistance at temperatures up to 1500 F. They are good against most acids and alkalis, but are attacked by strong hydrochloric acid and strong oxidizing acids. They are affected by sulfur-bearing gases above 500 F and steam above 800 F. Their sealability is relatively poor.

Nickel gaskets have lower corrosion resistance than monel but are still very good for most applications. They are good against chlorine up to 950 F but are subject to embrittlement by steam over 800 F. In general, they can be used to 1400 F. However, they have relatively poor sealability.

Inconel gaskets are mainly noted for their resistance to high temperatures—up to 2000 F. Because of their hardness they have poor sealing properties.

Steel (SAE 1010, 1020) gaskets perform best at low loads. They are relatively cheap and resist some strong acids and most alkalis. The gaskets can be used up to 1000 F but are attacked by sulfur-bearing gases over 600 F. The sealability is poorer than that of the soft metal gaskets.

Stainless steel gaskets are available in many different grades, including types 302, 304, 316, 347, 410 and 502. Chemical and thermal properties depend on the grade used.

Metal composites

The chief limitations of the harder metals as gasket materials are their relatively poor compressibility and sealing properties. These limitations can be overcome by combining the metal with softer materials such as asbestos, TFE or rubber, to produce a composite material (see Fig 3) which, with little sacrifice in chemical and heat resistance, has good compressibility and sealing properties.

Gasket manufacturers have designed a great many composite gaskets. Following is a brief discussion of the most commonly used type—spiral-wound metal gaskets. Keep in mind that many other designs are available which should be investigated if the spiral wound type does not appear suitable.

Spiral-wound gaskets are constructed of spiral-wound grooved metal strips alternated with layers of a nonmetallic material. The spring action of the metal provides automatic reaction to compression, internal pressure

changes and temperature variations. Also, nonmetallic filler material compresses under bolt load to improve sealing.

The chemical and temperature resistance of this type of gasket depend on the combination of metal and nonmetallic used. Type 304 stainless steel is most commonly used. However, many other metals are available for special applications including 316 stainless, plated low carbon steel, pure nickel, Inconel, phosphor bronze, copper and monel. These metals can be used with either asbestos or TFE fillers; asbestos is used for high temperatures and medium corrosion resistance, TFE for high corrosion resistance and moderate temperatures.

Leather

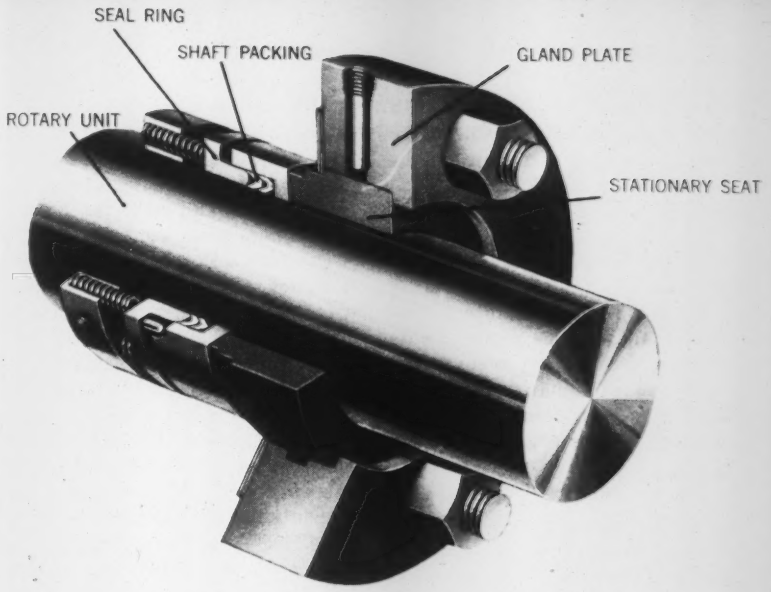
Because of its high mechanical strength and toughnees, leather is better suited for dynamic seals than for gaskets. Its limited chemical and heat resistance also make it less popular for gaskets than other materials such as rubber, TFE and asbestos. Leather is not recommended for use with steam under pressure or with acid or alkali solutions. Its useful temperature range is –70 to 220 F.

However, leather washers are particularly well adapted for use on valve stems and in small stuffing boxes where space is limited. To avoid excessive friction, they must not be tightened too much. Compression of the material should be limited to 10 to 15% of its thickness.

Leather gaskets are best suited for plain-faced flanges at low pressures. For higher pressures the metal surface should be recessed to overcome the spreading tendency of the material. Gaskets are available in a variety of shapes and can be made in any thickness by cementing two or more plies together.

Glass fabric

Gaskets made of glass fabric are mainly noted for their high strength and heat resistance. The fabric is not used alone but is coated with silicone or TFE resins. Silicone coatings are used to improve flexing resistance; TFE coatings improve chemical resistance and keep the gasket from sticking to the flanges.



Durametallic Corp.

Materials for Mechanical Seals

Compared to the other seals and packings described in this article, the mechanical seal (see photo) is a relatively complex mechanical device. The various components of the seal must be selected from materials that will: 1) resist the corrosive media, 2) be compatible with each other, and 3) be compatible with the rotating shaft. Some of the materials that can be used for the various seal components are:

Rotary unit: almost any machinable alloy.

Seal rings: ceramic or Stellite.

Shaft packing: TFE, CFE and others.

Gland plate: carbon and stainless steels, cast iron bronze and monel.

Stationary seat: bronze, carbon-graphite, and other good bearing materials.

Materials for packings and seals

Packings and seals are designed to prevent or restrict the flow of liquids or gases between surfaces which are in relative motion—rotary or reciprocating. Since they both perform the same function, it is difficult to make a distinction between packings and seals. However, the word packing usually refers to long, flexible, spiral-type materials which can be cut to size and made to fit a variety of surfaces. In contrast, the word seal is usually applied to materials that are used in ring form. The word seal is associated in some industries (particularly aircraft) with static sealing. However, for purposes of this article the term will be used in its most commonly used sense, i.e., in reference to applications involving motion.

Many factors must be considered in selecting a suitable packing or seal material. Most important, the materials must resist attack by the fluids they are sealing. Similarly, they must be compatible with the structural

materials they are in contact with. They must also be capable of resisting the effects of high and low temperatures. And, in addition, they must have adequate mechanical properties to resist the effects of wear, compression, shock and vibration.

Naturally, no one material can satisfy all of these requirements. As described below, many materials and combinations of materials have been developed to meet specific operating conditions.

Rubber

Practically all the rubber materials described in the section on Gasket Materials can be used for packings and seals. In addition, many other rubber and rubber composite materials are available. Selection of the best material for a particular application can be difficult. Keep in mind that the properties of each material depend not only on the base rubber stock but upon the compounding materials used. Dozens of compounds with widely varying properties can be made from a given base material. Hence the need for close liaison among the user, the gasket manufacturer, and the materials producer. In selecting the proper stock and compound, it is important to consider the media to be sealed, temperature, required part shape, operating pressure, and desired physical properties.

Following is a summary of the important types of rubber seals and packings and their properties:

O-rings—O-ring seals for dynamic applications are available in such materials as natural rubber, nitrile, SBR, neoprene, Viton fluoroelastomer, butyl and silicone. Resistance of these materials to specific media is described in the section on Gasket Materials.

Rubber O-rings can be used as dynamic seals for reciprocating motion on piston or shafts. At pressures over 1500 psi they should be used with backup washers to prevent extrusion. They have also proved practical in many rotary applications; however, as would be expected, design conditions are most critical. Relatively high durometer (80 to 84) compounds are required, tolerances and finishes must be closely controlled, and rings must have a minimum cross section.

Oil seals—Rotary oil seals are designed to seal liquids in one direction and dirt and foreign agents in the other direction. They were originally designed to seal oils and greases but can be used to seal other media as well. The seals consist of: a hard outer ring for structural strength and a spring loaded inner rubber lip which actually does the sealing (Fig 4). A nitrile rubber lip is commonly selected when sealing oils and greases. However, many other rubbers can be used, including butyl (chemical resistance), and silicone (cold and heat resistance), neoprene (resistance to petroleum products), and Viton Fluoroelastomer (resistance to heat and many fluids).

V-rings—These rings are widely used for packings. Their V-shape (Fig 5) permits the rings to be nested inside each other and permits a good sealing action when squeezed axially.

The rings can be made entirely of rubber or of various rubber composites. Selection of the best rubber and/or reinforcement for the rings depends on operating conditions. Plain rubber is good for low pressures, close tolerances and fine surface finishes. Composite rings of rubber and a cotton duck reinforcement are commonly used where high strength is needed. An asbestos reinforcement is popular for high temperatures. The rings can be coated with TFE to reduce friction.

Cups—Molded rubber cups are widely used as piston seals in hydraulic and pneumatic equipment. They are available in the same materials as V-rings. They can be reinforced with metal and are available with a TFE coating to reduce breakaway torque, reduce running friction, and eliminate squealing.

Other rings and packings—Many other rubber-base rings and spiral packings have been created to meet various operating conditions. Among the most important:

1. Plain, medium soft rubber packings designed for hot or cold water, aqueous solutions and ammonia gas.

2. Low pressure ring and spiral packings made of closely-woven plies of heavy cotton duck, treated with rubber, and with thick top and bottom covers of rubber. They are designed for hot or cold water and low pressure steam.

3. Spiral and ring packings made of cotton duck, treated with rubber, laid-up diagonally and finished with top and bottom covers of fabric and rubber. These packings are designed for hot and cold water, low pressure steam, and hot mixtures of anhydrous ammonia.

4. Layers of cotton duck impregnated with rubber and formed with a round, hollow center (to allow for expansion and motion). They are available in ring or spiral form for hot or cold water and low pressure steam.

5. A round core of rubber wrapped with a cotton duck impregnated with rubber. Use: hot or cold water and low pressure steam.

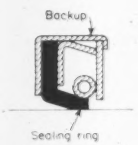


***Fig 4**—Oil seal rings consist of inner nonmetallic sealing ring and metal backup rings.*

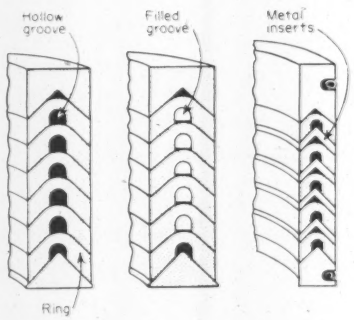


***Fig 5**—V-type rings provide sealing action when they are squeezed in longitudinal direction.*

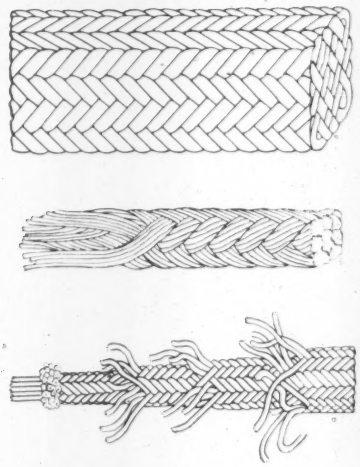


***Fig 6**—Three types of braid used for making asbestos packings.*

PACKING AND SEALING MATERIALS—A SUMMARY

Material ↓	Max Service Temp, F	Important Properties
RUBBER (straight)	To 600	See Gasket Materials for properties. Mainly used for ring-type seals, although some types are available as spiral packings
RUBBER COMPOSITES		
Cotton-Reinforced	350	High strength. Chemical resistance depends on type of rubber used; however, most types are noted for high resistance to water, aqueous solutions
Asbestos-Reinforced	450	High strength combined with good heat resistance
ASBESTOS		
Plain, Braided Asbestos	500	Heat resistance combined with resistance to water, brine, oil, many chemicals. Can be reinforced with wire
Impregnated Asbestos	To 750	Environmental properties vary widely depending on type of asbestos and impregnant used. Neoprene-cemented type resists hot oils, gasoline and solvents. Oil and wax-impregnated type resists caustics. Wax-impregnated blue asbestos type has high acid resistance. TFE-impregnated type has good all-around chemical resistance. See text for details
Asbestos Composites	To 1200	End properties vary widely depending on secondary material used. See text
METALS		
Copper	To 1500	Properties depend on other construction materials and form of copper used. Packing made of copper foil over asbestos core resists steam and alkalis to 1000 F. Packing of braided copper tinsel resists water, steam and gases to 1500 F
Aluminum	To 1000	Resists hot petroleum derivatives, gases, foodstuffs, many organic acids
Lead	550	Many types are available. See text
ORGANIC FIBER		
Flax	300	Good water resistance
Jute	300	Good water resistance
Ramie	300	Good resistance to water, brine, cold oil
Cotton	300	Good resistance to water, alcohol, dilute aqueous solutions
Rayon	300	Good resistance to water, dilute aqueous solutions
FELT	300	See section on Gasket Materials
LEATHER	To 210	Good mechanical properties for sealing. Resistant to alcohol, gasoline, many oils and solvents, synthetic hydraulic fluids, water
TFE	To 500	Available in many forms, all of which have high chemical resistance
CARBON-GRAPHITE	700	Good bearing and self-lubricating properties. Good resistance to chemicals, heat

Asbestos

Asbestos is a popular packing material because of its excellent heat resistance and good chemical resistance. The material is extremely versatile in that it can be impregnated or used in composite packings with many different materials to meet a wide range of requirements.

Impregnated types—The basic structure of impregnated asbestos packings can be made in many different weaves — from simply braided asbestos yarns to complicated interlocking braids (see Fig 6). Some of the braids are available with wire reinforcement. Choice of the best braid to use depends on the strength, wear resistance and other mechanical properties needed. Selection of the best impregnant or lubricant to use depends on operating speeds and the degree of chemical and heat resistance required. Here are just some of the end conditions that can be met with impregnated, interlocking asbestos braid packings:

1. General service — Braided white asbestos lubricated with a light oil and coated with graphite. Will handle hot and cold water, brine, oils and many chemicals at speeds to 3600 rpm and temperatures to 500 F. Can be reinforced with copper wire to resist shock, vibration and other mechanical conditions.

2. Resistance to hot oils, gasoline and solvents—Braided white asbestos containing neoprene cement. Impregnated with vegetable-base compound and finished with graphite. Usable to 3600 rpm and 500 F.

3. High resistance to caustics —Asbestos yarn impregnated with oils and wax having very low saponification number. Good to 3600 rpm and 500 F.

4. High acid resistance—Braided 100% blue African asbestos impregnated with inert waxes and coated with graphite. Good to 1800 rpm and 750 F.

5. All-around chemical resistance—Braided white asbestos im-

pregnated with TFE and lubricated with mineral oils. Has low friction and is good to 3600 rpm and 500 F.

Composite types—Asbestos can be combined with many other materials to improve its sealing and compression properties. Again, space does not permit analysis of all composites. However, here are some important types:

1. A U-shaped woven asbestos channel containing a wedge of bearing metal which contacts the moving surface (Fig 7). It is designed for use against steam, air or gas at temperatures to 500 F.

2. A rubber core wrapped with asbestos layers treated with a lubricant and coated with graphite (Fig 8). Designed for steam service to 300 psi and 300 F.

3. Braided asbestos and Inconel over a flexible core of graphite and asbestos (Fig 9). Designed for valves handling a wide range of chemicals at pressures to 5000 psi and line temperatures to 1200 F.

4. Braided asbestos and monel over a core containing asbestos, mica and neoprene. Designed for valves handling steam and other media at pressures to 5000 psi and temperatures to 1000 F.

5. Braided asbestos over a core of asbestos and graphite. Designed for valve stems in contact with hot and cold water, air, and natural and manufactured gases. Good to 3000 psi and 1000 F.

6. Asbestos jacket over an asbestos core. Designed for high flexibility at pressures to 300 psi and temperatures to 1000 F.

Metal

A wide variety of metals can be used as packings and seals in dynamic applications to prevent the leakage of liquids and gases. Although many different metals can be used for mechanical seals (see box) and piston rings, most conventional packings are made from three basic metals—copper, aluminum and lead—and combinations of these metals with various nonmetallics.

Copper is available in both coil and braided tinsel forms. Copper foil packings are made by wrapping the foil around a core of braided, dry asbestos (Fig 10). The structure is thoroughly lubricated and graphited to minimize friction and wear. The packings perform well against steam and alkalis at temperatures to 1000 F. Principal applications are centrifugal and reciprocating pumps, expansion joints, valves, and other equipment operating at high pressures and temperatures.

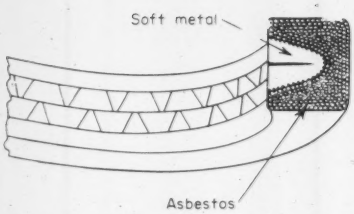


Fig 7—*Composite asbestos-metal packing combines good heat and wear resistance.*

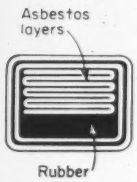


Fig 8—*Rubber core in this composite asbestos packing improves strength and flexibility.*

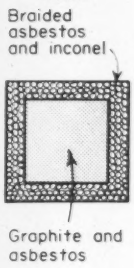


Fig 9 — *Strength and heat resistance are provided by combining a braided asbestos and Inconel cover with a graphite and asbestos core.*

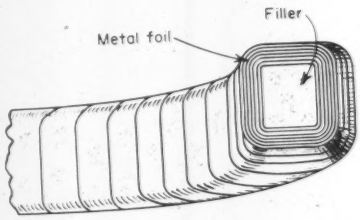


Fig 10—*Metal packings can be made in many constructions. Type shown here consists of metal foil over braided asbestos.*

Extra high heat resistance—to 1500 F—is obtainable with a copper tinsel material bonded with a rubber cement which is braided into a square cross section or molded into shape. This material resists water, steam, air and gases (except ammonia). Typical uses include reciprocating rods of compressors, engines and pumps, shafts of rotary and centrifugal pumps, and valve stems.

Aluminum foil packings are made by wrapping aluminum foil around itself or around a core of braided, dry asbestos. Like the copper foils, they are impregnated with lubricants and graphite to lessen friction and wear. They are designed mainly for use against hot petroleum derivatives, hot gases, foodstuffs and many organic acids at temperatures to 1000 F. Most important uses include centrifugal and reciprocating pumps, valves, still necks and expansion joints.

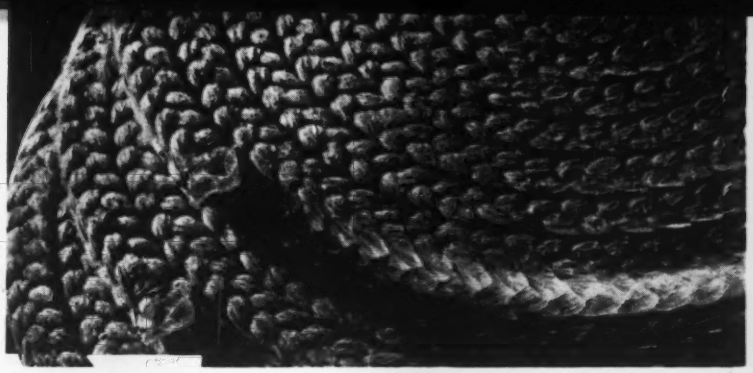
Lead, like copper, is available in foil, braided and shredded forms. Lead packings can be made entirely of lead or with an asbestos, flax or flexible core containing shredded lead, asbestos fiber, graphite and a lubricant. The lead foil–asbestos core packing resists steam, water, brine and oil up to 500 F. The flax core material is designed for use with water or oil to 150 F. And the flexible core packing withstands oils, solvents, steam, water and air to 500 F.

Lead foil can also be braided and combined with asbestos yarn and a rubber core. These composite packings are designed to seal steam, water, air, natural gas, ammonia and other gases up to 500 F.

Another foil-type packing consists of strands of lead foil bonded with a special rubber cement and enclosed in a graphite-coated cotton yarn. This packing can be used up to 500 F against steam, water, air, ammonia and other gases.

The simplest braided lead packing available consists of square braided lead wire treated with a mineral fat lubricant and a surface coating of graphite. This packing is designed for use with steam, water, ammonia and other gases to 500 F.

Another lead packing consists



Garlock Packing Co.

***Flax** packings can be treated with paraffin, marine fats and graphite to make them resistant to cold water and other liquids at low and medium pressures.*

of alternate conical rings of molded shredded lead and solid sheet lead. This packing material is intended for steam, oils, solvents, air and gases (such as carbon dioxide, methyl chloride or freon) at temperatures to 500 F.

Other metals used as packings and seals are primarily used in mechanical seals and piston rings. Space does not permit analysis of the wide variety of piston ring materials available such as stainless steel, cast iron, bronze, Haynes 25, and many others. However, detailed information is readily available from piston ring suppliers.

Organic fiber

Organic fibers are among the oldest packing materials known. Their chemical resistance is not as good as that of many of the newer packing materials. However, they are still widely used today, mainly because of their low cost and their good performance in hydraulic applications against cold water and mild aqueous solutions.

Flax—The end service properties of braided flax packings can be varied over a wide range, depending on the length of fibers used, the type of braid, and the kind of impregnant used. Long-fiber flax roving can be treated with a modified paraffin lubricant to produce a relatively hard packing. Alternatively, it can be treated with a blend of paraffin and a marine fat lubricant to give a hard, medium or very soft packing.

All of the above packings are suitable for cold water and hydraulic service at medium or low pressures. Packings impregnated with a modified marine fat or graphite lubricant are available for heavy hydraulic service. In addition, flax can be combined with jute or rubber cushioning. Many combinations are available to seal cold water at low, medium and high pressures, and the packing supplier should be consulted in order to select the best material.

Jute—The properties of jute packings are quite similar to those of flax packings. Like flax, jute is braided from high grade, long fibers and is treated with such materials as paraffin, mineral oil, marine fats and graphite to vary hardness and density. The packings are intended mainly for cold water service at low or medium pressures.

Ramie — In general, braided Ramie packings have higher strength than other organic fiber packings. They are practically immune to mildew and will not deteriorate when exposed to cold water, salt water, brine and cold oil.

Cotton—In addition to being used as a reinforcement in composite seals and packings, cotton can also be used alone or as a braided packing. The properties of cotton packing can be improved by impregnation with various lubricants and by an external graphite treatment. When properly treated, the packings have good resistance to hot and cold water, alcohol, and dilute aqueous solutions.

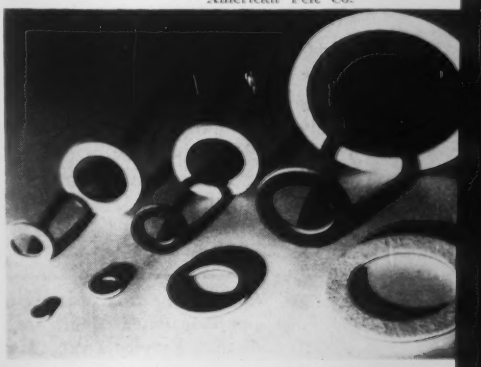
Rayon—The properties of rayon and vegetable fiber packings are quite similar. Braided rayon packings, thoroughly impregnated with marine fat and graphite lubricants, perform well in heavy hydraulic service against cold water. Packings lubricated with marine fat and paraffin lubricants have good resistance to cold water and dilute aqueous solutions at medium and low pressures.

Felt

Most of the felt materials described under Gasket Materials can also be used for seals and packings in dynamic applications. As previously explained, the chemical resistance and mechanical

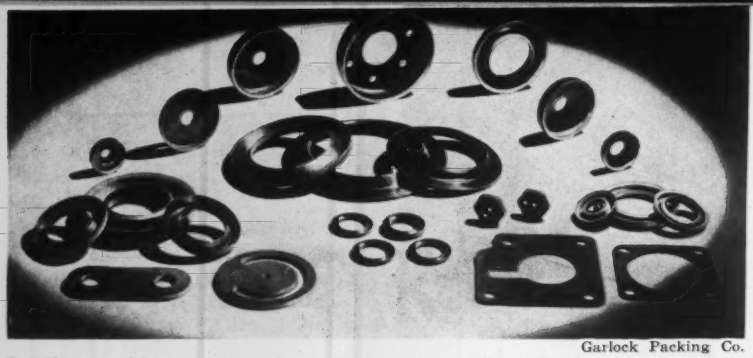
***Felt** can be treated with rubber, TFE, lubricants and other materials to meet a wide range of sealing conditions.*

American Felt Co.



Where to Obtain More Information

This manual is intended to serve as an initial selection guide in choosing a gasket, packing or seal material. In a manual of this length it is impossible to describe more than the general mechanical properties and corrosion resistance of each material. In many cases, detailed data on such properties as compression set or resistance to a specific chemical can be obtained from the gasket or packing distributor. Gasket and packing fabricators are also a good source of information. And, in addition, excellent property information can be obtained from the raw materials supplier. For a good starting point on which companies to contact, see the companies listed in the acknowledgment on p 126.



Garlock Packing Co.

***Leather** packings resist water, oils, gasoline, mild acid solutions, and many gases at low or medium temperatures and medium to high pressures.*

properties of felt can be varied with the kind of impregnants that are added to the material. In general all compositions are suited for relatively low speed applications.

Leather

Leather is the oldest dynamic sealing and packing material known and is still widely used today. Because of its porous structure the material can be coated or impregnated to provide varying degrees of hardness and flexibility. An oil, grease, soft wax or synthetic impregnant is generally used for low pressure seals requiring high flexibility. For high pressures, a firmer leather and harder impregnating materials are used. The material can be cut and stitched into many packing shapes and can also be molded into cup, flange, U and V seals.

The inherent lubricity and low coefficient of friction of impregnated leather packings help keep heat generation down and increases life. In addition, because of their high strength, leather packings will withstand very high pressures with minimum cold flow and extrusion. Almost all leather packings can be used at temperatures ranging from –30 to 150 F. Special packings are available for temperatures from –70 to 210 F.

Although their chemical resistance is not as good as that of some plastics and rubber packings, leather packings can effectively seal many common media including: alcohol, gasoline, many oils and solvents, synthetic hydraulic fluids and water. However, acids and alkalis should be avoided.

Plastics

TFE fluorocarbon is the only plastic being used to a significant extent for seals and packings. As pointed out in the section on Gasket Materials, TFE has excellent chemical resistance and very good heat resistance. It is an extremely versatile sealing and packing material and is available in many configurations. Following are the most important types:

Braided packings—Braided TFE packings can be divided into three categories, depending on method of manufacture.

1. Braided asbestos fibers impregnated with 10 to 40% TFE are widely used for packings. They are most commonly used for valves, but can also be used in pumps and other high speed devices.

2. Ribbons of TFE tape can be twisted and braided into packings with high chemical resistance. In almost all cases some asbestos yarn is incorporated into the packing and the pores of the packing are impregnated with a TFE dispersion.

3. Continuous-filament TFE yarn can be braided into packing with exceptional strength and resiliency. Depending on the hardness required, the packing is usually impregnated with 10 to 35% TFE.

Ring seals and packings—TFE is available in many ring shapes to suit different requirements. Simple cylindrical rings provide excellent performance on valve stems and slow moving parts. They are easy to make and are impervious to gases and liquids. If necessary, their deformation properties can be improved by adding glass, calcium, fluorides, graphite or other fillers.

Other TFE ring shapes available include tapered rings, V-rings and O-rings. Each configuration produces a different kind of sealing action. The tapered rings, for example, seal by a wedging action, and the V-rings seal by a spreading action.

Carbon-graphite

Carbon-graphite is used almost exclusively in ring form. Although the material is relatively hard it has a number of important advantages. It is particularly noted for its good bearing and self-lubricating properties. In addition, the porosity of the material can be controlled so as to make it either completely impervious, or semiporous to allow some penetration of liquid for lubricating purposes.

Carbon-graphite seals also have excellent chemical and heat resistance. They resist attack by many chemicals, but not strong hot oxidizing acids and alkalis. They have good dimensional stability, high resistance to thermal shock, and can be used to about 700 F. A further advantage is their ability to be molded in many shapes and sizes.

Acknowledgments

The author would like to express his appreciation for the assistance of personnel and literature from the following companies in preparing this article:

Albert Troxtel Packings, Ltd.
American Felt Co.
Armstrong Cork Co.
Associated Gaskets, Inc.
B. F. Goodrich Co.
Chemical & Power Products, Inc.
Chicago Rawhide Mfg. Co.
Crane Packing Co.
Durabla Mfg. Co.
Durametallic Corp.
E. I. du Pont de Nemours & Co., Inc.
F. D. Farnum Co.
Flexitallic Gasket Co.
Garlock Packing Co.
Goodyear Tire & Rubber Co.
Greene, Tweed & Co.
Hecht Rubber Co., Inc.
International Packings Co.
Johns-Manville Corp.
Latex Fiber Industries, Inc.
Lead Alloy Products Co.
Navan Products, Inc.
Packing Engineering Corp.
Parker Seal Co.
Pure Carbon Co., Inc.
Raybestos-Manhattan, Inc.
Rogers Corp.
Rubatex Div., Great American Industries, Inc.
Taylor Fibre Co.
U. S. Graphite Co.
Vulcan Lead Products

Reprints of this Manual are available at 35¢ each until supply in exhausted. Turn to p 156 for complete list of available Manuals. Write for quotations on quantities of 100 or more. Address Reader Service Dept., MATERIALS IN DESIGN ENGINEERING, *430 Park Ave., New York 22, N.Y.*

first in silicones

Dow Corning

SILICONE NEWS

for design and development engineers • No. 69

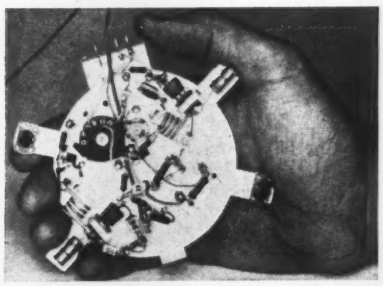
STOP ELECTRICAL LEAKAGE

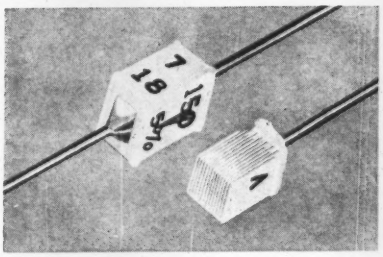
A thin coating of silicone fluid on electrical and electronic units is all it takes to prevent leakage paths. Here's how Vitramon Incorporated, Bridgeport, Connecticut, assures the reliability of its capacitors for missiles, aircraft and earth satellites.

"Vitramon" Capacitors must be able to withstand a wide variety of adverse environments both during storage and in operation. Consequently, the capacitors have porcelain bodies impervious to moisture. But condensation on the porcelain can form a conductive moisture film, permitting lead-to-lead short circuits.

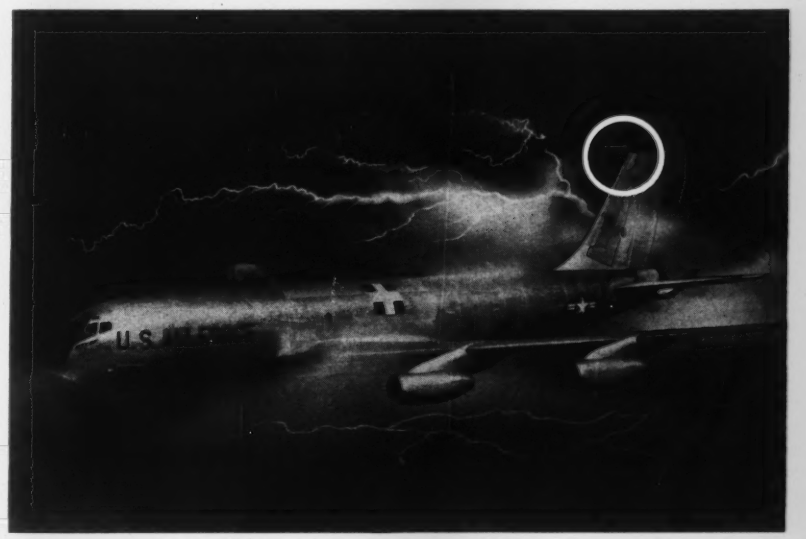
Vitramon easily eliminates this by dipping the capacitors into a solution of Dow Corning silicone fluid. Easily applied, the silicone coating produces a thin, non-oily coating that causes condensation to bead, prevents formation of a conducting film and eliminates the possibility of shorts. In addition, the slick silicone coating protects the capacitors during handling and storage.

A typical application: "Vitramon" Capacitors play an important role in the tele-





metering transmitter (illustrated above) employed in the Vanguard missile. Other uses include guidance tracking and computing units on the Bullpup, Falcon, Explorer and other missiles, as well as on nonmilitary equipment. *No. 241*



LIGHTNING BARRIER

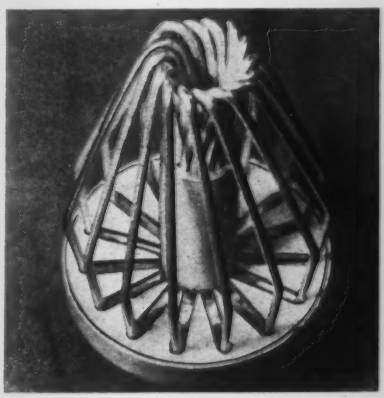
The structural and dielectric properties of silicone-glass laminates are the key to the solution of many intricate design problems. Here's a good example: the Aircraft Lightning Arrester made by Joslyn Manufacturing and Supply Company, Chicago.

Aircraft are protected against lightning by metal skin and positive electrical bonding of movable surfaces. But long range HF communications systems of jet aircraft with probe-type antennas were subject to destruction by electrical discharge . . . until Joslyn engineers developed an effective lightning arrester.

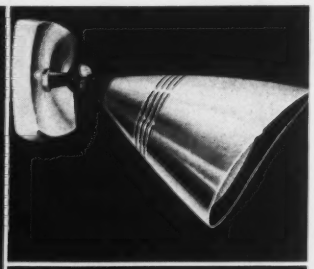
Mounted near the antenna's base, the Joslyn arrester permits a normal flow of radio energy but diverts lightning current to the aircraft structure along a preferred path. A key component of the arrester is a slotted silicone-glass laminate spring guide. Punched from 0.0625 inch thick Phenolite G-7-832 made by National Vulcanized Fibre Company of Wilmington, Delaware, the slotted laminate serves as both retainer and insulator for 15 flexible phosphor bronze spring elements.

The Joslyn Aircraft Lightning Arrester is designed to operate at altitudes up to 50,000 feet and will withstand temperatures ranging from —80 F to over 160 F. Its construction is designed to safely discharge lightning strokes having peak current as high as 100,000 amperes and 200 coulombs charge.

Phenolite G-7-832 made with Dow Corning Silicones was selected because it provides



the high physical and high dielectric strength required; withstands severe vibrations without fatigue or breakdown; is resistant to fungus growth; and allows the spring elements to move in and out on a guided, insulated path with no danger of touching any other metal surface. Easy fabrication of the silicone- *(Cont. Pg. 2)*



PROTECTS AND SEALS FLOODS

Designing quality outdoor lighting — floods, spots, clusters — is an exacting science at Stonco Electric Products Company, Kenilworth, New Jersey. And Stonco engineers report that Silastic®, the Dow Corning silicone rubber, provides a long-lasting water-tight seal . . . assures reliability in every kind of weather, even with the lamp face up.

Currently producing outdoor lighting engineered to meet every commercial and industrial need . . . from ball park lighting to portable floodlights for emergency squads . . . Stonco Electric is adding a complete new line of decorative outdoor "bullet" spots for home use.

Stonco designers specify that the gaskets for all their top quality outdoor lampholders be made of Silastic. They report that in addition to providing a weatherproof seal, the durably resilient silicone rubber gaskets lock the lamps securely in their sockets, and cushion them against pole whip and vibration . . . help provide longer lamp life.

This is another instance where the unusual properties of Silastic helped engineers design a better product. Serviceable from —130 to 500 F and resistant to weathering, oxidation and electrical breakdown, Silastic parts and components play important roles in many aircraft, automotive, electrical and electronic applications. For more information on the properties of Silastic and the advantages this silicone rubber can offer you in the products you design, circle ..... *No. 242*

GLASS LAMINATES *(Continued)* glass laminate provides another "plus." Despite their intricate shape, the spring guides are punched out with little difficulty.

This combination of properties is the reason silicone-glass laminates are so practical — so widely used both as electrical components and as structural members in aircraft and in electrical and electronic equipment. *No. 243*

PROPERTIES OF SILICONE-GLASS LAMINATES
(NEMA Standards for Sheets)

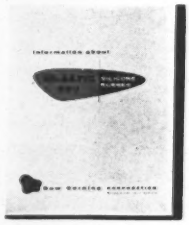
Flexural strength, flatwise, 1/8 inch thickness	20,000 psi min.
Izod impact strength, edgewise	6.5 min.
Dissipation factor at 1 megacycles, 1/8 inch thickness, condition A	0.003 max.
Arc resistance, seconds, Condition A	180 min.
Condition D 48/50	180 min.

new literature and technical data on silicones

Summary of Silastic Stocks and Pastes is a convenient index to properties, uses, and processing techniques of the 17 Silastic stocks and pastes usually selected to meet a range of performance requirements. This four-page compactly organized listing is prepared to help designers select at a glance the most useful silicone rubber for any application. *No. 244*

Solution Found—A reprint from Missile Design & Development describes how high voltage power supply units are potted with Dow Corning Dielectric Gel . . . and how the use of this unique, transparent resilient silicone product in missile-borne electronic equipment provides noteworthy advantages not attainable with other potting materials. A valuable aid in designing toward miniaturization and greater reliability. *No. 245*

Where, When and How you can use Silastic RTV advantageously is detailed in a new folder bulletin. Complete information on the various Dow Corning silicone rubbers that vulcanize at room temperature is presented in several fact filled data sheets written to aid in all applications. Whether you need prototypes, or want to caulk, seal or gasket a unit, or have to mold intricate parts, you'll want a copy of this reference folder. *No. 246*



Greater Stability Plus. Silicone diffusion pump fluids make the operation of pumps more efficient over longer periods of time and under more adverse conditions. After as many as 1100 cycles of heating to operating temperature and partial cooling, with exposure to air during each cycle, silicone fluids do not decompose into gums or tars. Rapid recovery, quick pump-down, inertness, fine vacua and economy are other advantages of using Dow Corning diffusion pump fluid. *No. 247*

Dow Corning Corporation, Dept. 7024, Midland, Michigan

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TITLE _____

COMPANY _____

STREET _____

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FOR DATA RELATING TO THESE ARTICLES, CIRCLE REFERENCE IN COUPON ABOVE, OR REFERENCE NUMBER ON READER SERVICE CARD

FILE FACTS

Properties of Bolts for Use at 1600 F[a]

Bolt Material →	M252[b]	Udimet 500[c]	Hastalloy R-235[d]	Waspaloy[e]
TENSILE STRENGTH				
Room Temperature				
Material, 1000 psi	184.0-184.6	167.8-169.0	167.0-168.0	181.0-182.0
Bolt (avg), 1000 psi	168.5	164.0	151.0	159.0
Bolt (½-20), lb	26.8-27.0	26.0-27.1	24.4-24.6	25.5-26.2
1200 F				
Material, 1000 psi	156.2-157.8	150.0-151.0	141.8-142.0	157.8-159.0
Bolt (avg), 1000 psi	151.0	151.0	134.0	140.0
Bolt (½-20), lb	23.7	24.4	21.5-21.7	22.0-22.6
1600 F				
Bolt (avg), 1000 psi	86.0	108.0	94.0	94.0
Bolt (½-20), lb	13.7-13.8	17.1-17.2	14.9-15.0	14.6-15.0
YIELD STRENGTH				
Room Temperature				
Material, 1000 psi	134.0-134.8	135.0-136.0	97.4-98.4	107.0-107.9
Bolt (avg), 1000 psi	121.0	125.0	102.0	109.0
Bolt (½-20), lb	19.5-20.0	19.9-20.0	16.0-16.2	16.5-19.0
1200 F				
Material, 1000 psi	101.0-102.0	110.0-112.0	90.0-90.8	89.7-90.2
Bolt (avg), 1000 psi	108.0	116.0	92.0	98.0
Bolt (½-20), lb	17.0	17.5-18.5	14.0-14.5	14.6-16.0
1600 F				
Bolt (avg), 1000 psi	71.5	88.0	72.5	70.5
Bolt (½-20), lb	11.2-11.3	13.9-14.0	11.0-11.8	11.0-11.8
SHEAR STRENGTH (of bolts)				
Average Strength, 1000 psi	132.0	130.0	115.0	137.0
Max Load (½-20), lb[f]	51.5-52.3	51.0-51.1	45.0-45.3	53.0-53.8
DUCTILITY (of material), %				
Elongation	25.8-26.2	9.0-9.3	27.0-27.6	20.0-21.1
Reduction of Area	22.0-22.7	10.0-10.7	24.2-25.2	18.0-18.6
STRESS-RUPTURE (of bolts), hr				
1200 F				
80,000 Psi	—	—	121.0-131.6	—
100,000 Psi	102.4-158.6	36.1-40.0	8.0-12.3	234.3-448.8
115,000 Psi	93.6-101.2	9.5-14.3	—	32.8-44.8
1500 F				
30,000 Psi	100.0-110.0	101.0-103.5	102.1-106.0	104.2-110.0
40,000 Psi	38.3-56.0	37.2-47.8	29.6-47.0	29.3-31.4
1600 F				
30,000 Psi	8.8-12.7	20.5-30.5	17.1-24.2	17.3-21.9
FATIGUE STRENGTH (of bolts), 1000 cycles				
77,000 Psi	42.3-48.1	236.0-281.0	46.1-53.7	21.8-28.3
100,000 Psi				
As Received	7.4-10.4	11.2-13.6	7.9-10.6	16.7-22.0
Soaked 100 Hr (1600 F)	10.4-19.7	26.7-32.2	9.1-11.3	14.7-33.2
COEF OF THERMAL EXPANSION, per °F				
600 F	6.5	7.4	7.5	7.4
1200 F	7.5	8.0	8.1	8.0
1600 F	8.4	8.9	8.8	8.9

[a] Materials property values are based on 0.357-in. specimens with tensile loading at 0.005 in./in./min. Bolts were loaded at 65,000 psi/min and psi values are based on tensile stress area as defined in Handbook H-28, *Screw Thread Standards for Federal Services.*

[b] Solution treated 4 hr at 1950 F, air cooled; aged 15 hr at 1400 F, air cooled.

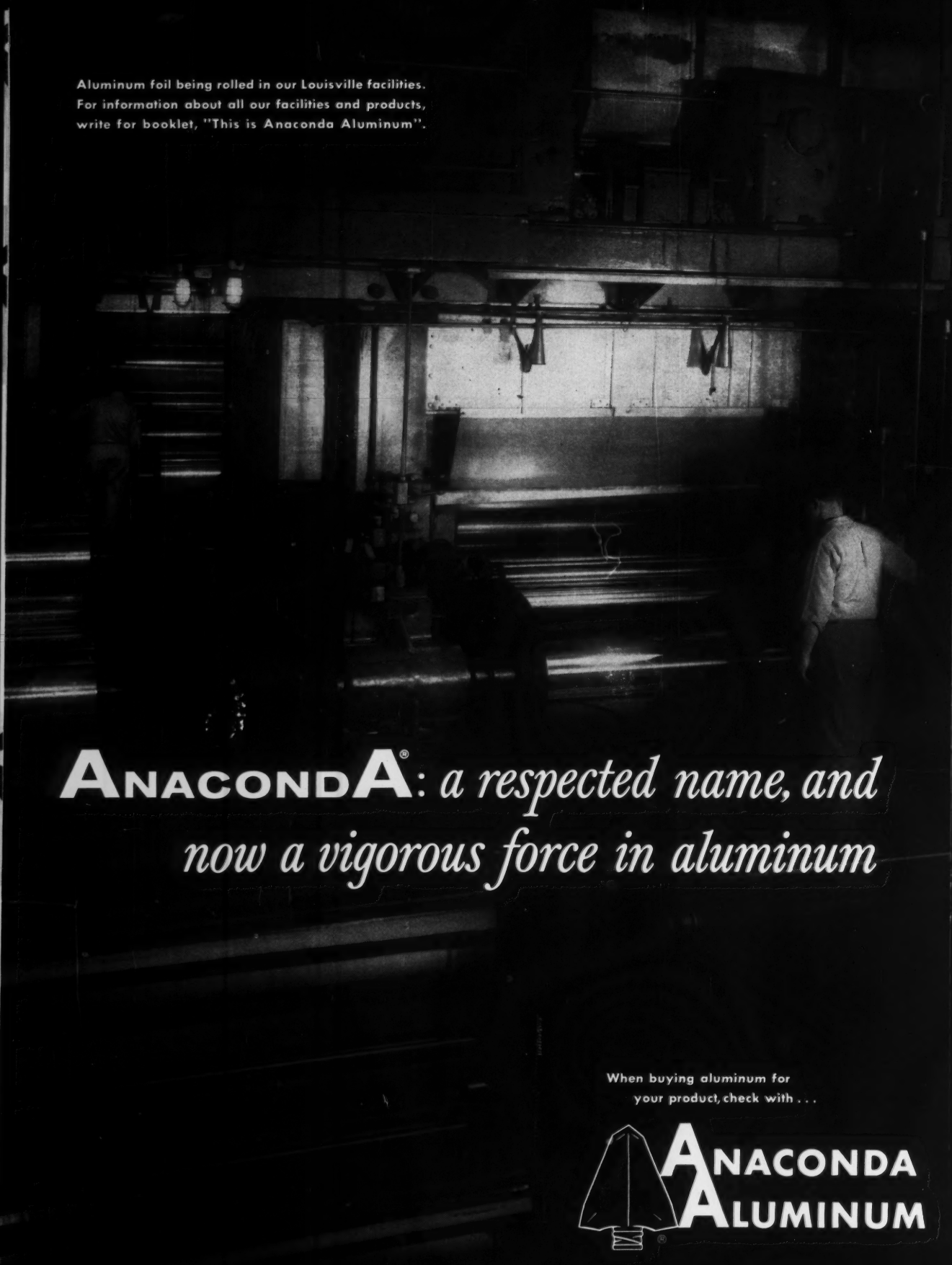
[c] Solution treated 2 hr at 2150 F and 4 hr at 1975 F; aged 24 hr at 1550 F and 16 hr at 1400 F. Air cooled after each operation.

[d] Solution treated 2 hr at 2150 F; air cooled; aged 1 hr at 1600 F; air cooled.

[e] Solution treated 4 hr at 1975 F; aged 2 hr at 1550 F and 16 hr at 1400 F. Air cooled after each operation.

[f] Double shear test.

Source: Prepared from data supplied by Standard Pressed Steel Co.



Aluminum foil being rolled in our Louisville facilities.
For information about all our facilities and products,
write for booklet, "This is Anaconda Aluminum".

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When buying aluminum for
your product, check with . . .

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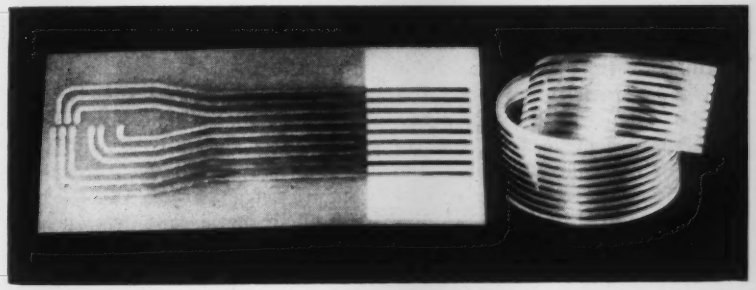
Containers, molds, gaskets *can be formed from FEP film.*



Printed circuit *(left) and printed flexible cable are made of Teflon FEP fluorocarbon film.*

FEP Fluorocarbon Resin Film Has Good Electrical Properties

■ Pinhole-free, uniform FEP fluorocarbon film will be commercially available for the first time late this month.

The base price, now $29 per lb, will be dropped to $15 per lb once production gets going (this date has not been set). The developer, E. I. du Pont de Nemours & Co., Inc., Film Dept., Wilmington 98, Del., says it expects further price reductions as volume increases and manufacturing efficiencies are improved.

The new film will be supplied in gages ranging from ½ mil to 40 mils.

The chemical description of the new resin, fluorinated ethylene propylene (FEP), has been adopted to distinguish it from conventional Teflon, tetrafluoroethylene (TFE). Teflon FEP resin is much easier to process than conventional TFE resin and has higher impact strength. Otherwise it is similar in specific gravity, tensile strength, flexural modulus, hardness and brittleness temperature.

Teflon FEP fluorocarbon resin, made only in development quantities to date, was introduced in late 1956 (see *Materials & Methods*, Nov '56, p 161, and M/DE, Apr '58, p 171).

Potential uses

Electrical devices—Largest immediate market for the film is expected to be in the electrical and electronic fields. According to the developer, Teflon FEP fluorocarbon film has outstanding electrical insulating characteristics and retains them over wide ranges of both temperature and frequency.

The film is expected to be used in coil-wound devices, capacitors, wire and cable, and rigid and flexible printed wiring and circuits, particularly when difficult operating conditions will be encountered or when high reliability is required.

Du Pont says the small quantities of the film available thus far

PROPERTIES OF FEP FLUOROCARBON FILM

PHYSICAL PROPERTIES	
Density, lb/cu ft	0.078
Coef of Ther Exp (—100 to 160 F), per °F	4.61-5.85
Ther Cond, Btu/hr/sq ft/°F/in.	1.35
Water Absorption, %	0.01
Svc Temp Range, F	
Continuous	-120 to 390
Intermittent	-120 to 480
MECHANICAL PROPERTIES	
Tensile Strength, psi	3000
Elongation, %	250
Mod of Elast in Tension, psi	43,000
Tear Strength, lb/in.	600
ELECTRICAL PROPERTIES	
Dielectric Strength, v/mil	
1 Mil Thick	3200
15 Mil Thick	1500
Dielectric Constant	2.2
Dissipation Factor	0.0002
Volume Res, ohm-cm	$>10^{17}$
Surface Res, ohm	$>10^{13}$
Arc Res, sec	>165

◀ For more information, circle No. 378

have been used in applications of this type and have made significant contributions in military and other equipment.

Mold release—Teflon is literally as slippery as ice and its release properties have been used in many industries, usually in the form of coatings or impregnations. In a simpler operation, the new film can be applied directly to many surfaces to achieve the same result. For example, slick molds for releasing candy or plastics can be fabricated directly from the film by vacuum forming.

Pipe linings—The film's chemical inertness, together with its fabricability, suggests its use for corrosion resistance in equipment and pipe linings and in specialized containers.

Properties

The FEP fluorocarbon film is said to have outstanding heat and chemical resistance, excellent electrical characteristics, and other properties particularly useful in industrial applications. It is heat sealable, vacuum and heat formable, can be metallized, and in many instances can be bonded to other materials without adhesives. The film is transparent in thin gages.

Chemical resistance—The film is inert to virtually all known chemicals and solvents at temperatures up to 400 F. It has no known solvent and is affected only by alkali metals and certain complex halogenated compounds at elevated temperatures.

PERMEABILITY OF FEP FILM
(gm/hr/100 sq m/mil)

Nitrogen	12
Oxygen	30
Carbon Dioxide	40
Ethanol	4
Acetone	56
Benzene	36

Weather resistance—Resistance of the film to degradation by weathering is exceptional, according to Du Pont. Tests to date indicate the film's outdoor life is virtually unlimited. No adverse effects have been noted in long exposure, either natural or accelerated.

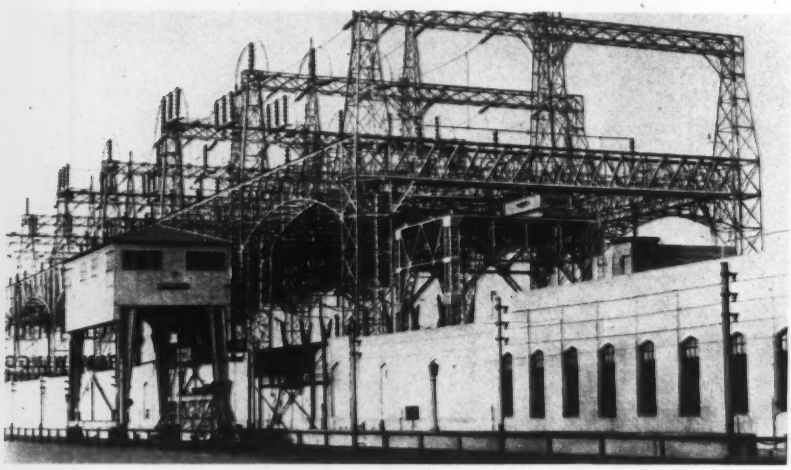
Other properties—In addition the film offers: toughness and strength, which are retained over a wide temperature range; lack of moisture absorption; and low permeability to liquids, gases, moisture and organic vapors.

Stainless-Steel-Pigmented Paint

■ A newly developed paint pigmented with stainless steel is said to have a life expectancy of at least 12 yr in corrosive atmospheres. The paint, designated No. 13448, is now commercially available from Vita-Var Corp., 10 Commerce St., Newark 2, N. J.

Other advantages of the paint are:

1. A smooth surface which sheds dirt and dust.
2. Minimum chalking.
3. Excellent hiding power when



Paint protects *gasoline storage tank (above) and electrical substation towers (right).*

applied in a single coat.

The new paint is designed for exterior use on steel and weathered galvanized iron structures such as storage tanks, oil well equipment, bridges and transmission towers. The developer says long life can be obtained only when the paint is applied over properly primed surfaces or over old paint that is in good condition. The paint should never be applied directly to bare metal, according to Vita-Var.

The paint contains a mixture of stainless steel flakes (18% Cr, 8% Ni) and several nonmetallic pigments in a long oil-alkyd resin vehicle. It can be thinned with mineral spirits.

The stainless steel-pigmented paint can be applied by brush, roller or spray at a rate of 450 to 500 sq ft per gal. It dries to a semigloss finish in 24 hr and takes on a bright, metallic appearance after weathering for approximately two years.

The dried paint withstands temperatures up to 400 F.

Titanium Alloy Has Highest Strength-Weight Ratio

■ A new titanium alloy, said to have a higher strength-weight ratio than any commercially available structural engineering material, is being produced by Oregon Metallurgical Corp., P. O. Box 484, Albany, Ore., Mallory-Sharon Metals Corp., 980 Warren Ave., Niles, Ohio, Crucible Steel Co. of America, Titanium and Vacuum Metal Products Div., P. O. Box 2518, Pittsburgh 30, and Titanium Metals Corp. of America, 233 Broadway, New York 7.

The alloy was developed jointly by the Research Div. of New York University's College of Engineering and Watertown Arsenal Laboratories.

A modified version of conventional 6 Al-4 V titanium alloys, the new material was developed to fill a need for a high strength alloy with good ductility. Nominal composition of the alloy is 6 aluminum, 6 vanadium, 2 tin, 0.5 iron, 0.25 copper and 85.25% titanium.

MECHANICAL PROPERTIES OF FABRICATED TITANIUM COMPONENTS

Type of Fabrication ↓	Section Size, in.	Ten Str, 1000 psi	Yld Str (0.1% offset), 1000 psi	Elong, (in 1 in.), %	Red. of Area, %	Charpy Impact Str (-40 F), ft-lb
Open Die Forging	¾[a]	190	181	9.5	25.8	6.4
Closed Die Forging	1[a]	181	173	10.0	27.8	9.3
Backward Extrusion	¾[b]	175	165	11.1	26.5	9.6
Forward Extrusion	½[a]	195	180	9.0	22.0	8.0
"Floturned"	0.073[c]	169	162	12.0	32.5	—

[a]Held 1½ hr at 1630 F, water quenched, held 4 hr at 1100 F, air cooled.
[b]Held 1½ hr at 1680 F, water quenched, held 4 hr at 1200 F, air cooled.
[c]Held 4 hr at 1100 F, air cooled.

The alloy is said to have excellent forgeability and excellent machinability. Welding may be difficult, but is being investigated further. Mechanical properties of fabricated components are given in the accompanying table.

***Searing heat** of plasma jet vaporizes Multiform fused silica. Other materials melt and flow as a liquid when exposed to the plasma jet.*

High Purity Fused Silica Produced in New Shapes, Sizes

■ A technique for producing high purity fused silica in shapes and sizes never before possible has been developed by Corning Glass Works, Corning, N. Y. The developer says parts made by the process can be machined to tolerances of ±0.001 in. Samples are now available from Corning's New Products Section.

Earlier this year Glasrock Corp. developed a technique for producing crack-free, self-supporting fused silica shapes in sizes up to 6 ft square by 11 in. thick (see M/DE, June '59, p 115).

How parts are made

Corning's technique forms fused silica into cylinders, domes, crucibles, rods and slabs through an adaptation of the Multiform process already used to form conventional glass into a wide variety of precise shapes and intricate patterns (see *Materials & Methods*,

Oct '54, p 94). Sizes equal to any achieved by conventional ceramic forming processes are possible, according to Corning.

The Multiform process closely resembles powder metallurgy techniques. Powdered glass is mixed with a binder, molded and sintered to form a vacuum-tight monolithic structure with a density about 98% that of the parent glass. The resultant parts retain the desirable characteristics of glass, such as thermal endurance, corrosion resistance and dielectric strength.

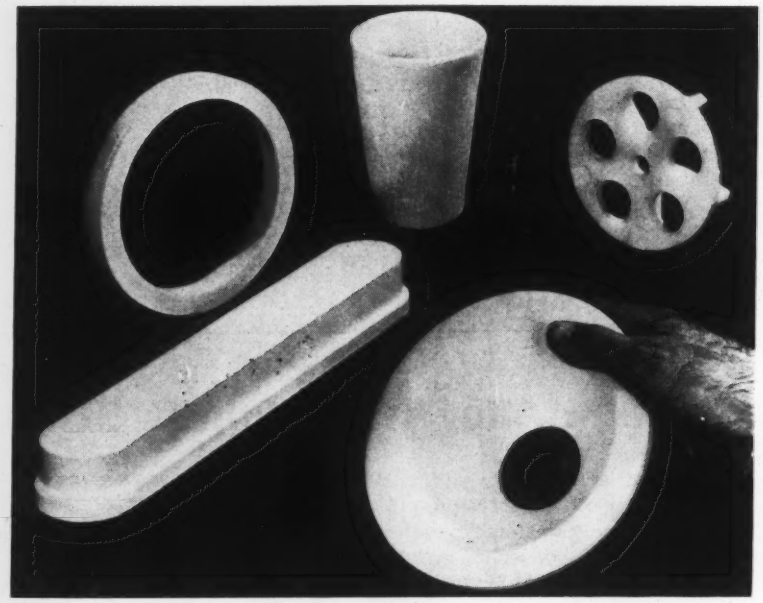
Properties and uses

Fused silica is one of the purest glasses commercially available. Impurity levels in the glass are on the order of 1 ppm. The glass is made by condensing gaseous silica into a solid slab.

Because of its good thermal and electrical characteristics, Multiform fused silica currently is under evaluation for possible use as a flush mounted radome in a military missile, according to the producer.

Heat resistance—The material can withstand long-term use at temperatures over 1700 F and intermittent use to 2250 F. The softening point is 2880 F. Coefficient of thermal expansion is 3×10^{-7} per °F, giving the material excellent resistance to thermal shock.

Multiform fused silica is extremely viscous at high temperatures and tends to sublime before it can liquefy and flow. Tests of the material in a plasma jet show



Fused silica parts *are made through an adaptation of Corning's Multiform cold glass-working method which is said to closely resemble powder metallurgy techniques.*

PROPERTIES OF MULTIFORM

PHYSICAL PROPERTIES	
Density, lb/cu ft	120-125
Porosity, %	9-13.6
Coef of Ther Exp (77-1740 F), per °F	3.0×10^{-7}
Spec Ht, Btu/lb/°F	0.223
Water Absorption, %	7-12.5
Ther Cond, Btu/hr/sq ft/°F/ft	0.514
Softening Temp, F	2880
MECHANICAL PROPERTIES	
Mod of Rupture, 10^3 psi	5
Shear Mod, 10^6 psi	2.07
Bulk Mod, 10^6 psi	2.26
Poisson's Ratio	0.15
Mod of Elast, 10^6 psi	4.74
Max Service Temp, F	2200
ELECTRICAL PROPERTIES	
Dielectric Constant	
Room Temperature	3.58
750 F	3.57
Dissip Factor	
Room Temperature	0.00069
750 F	0.00098

Polyester-coated steel sold in continuous coils 138
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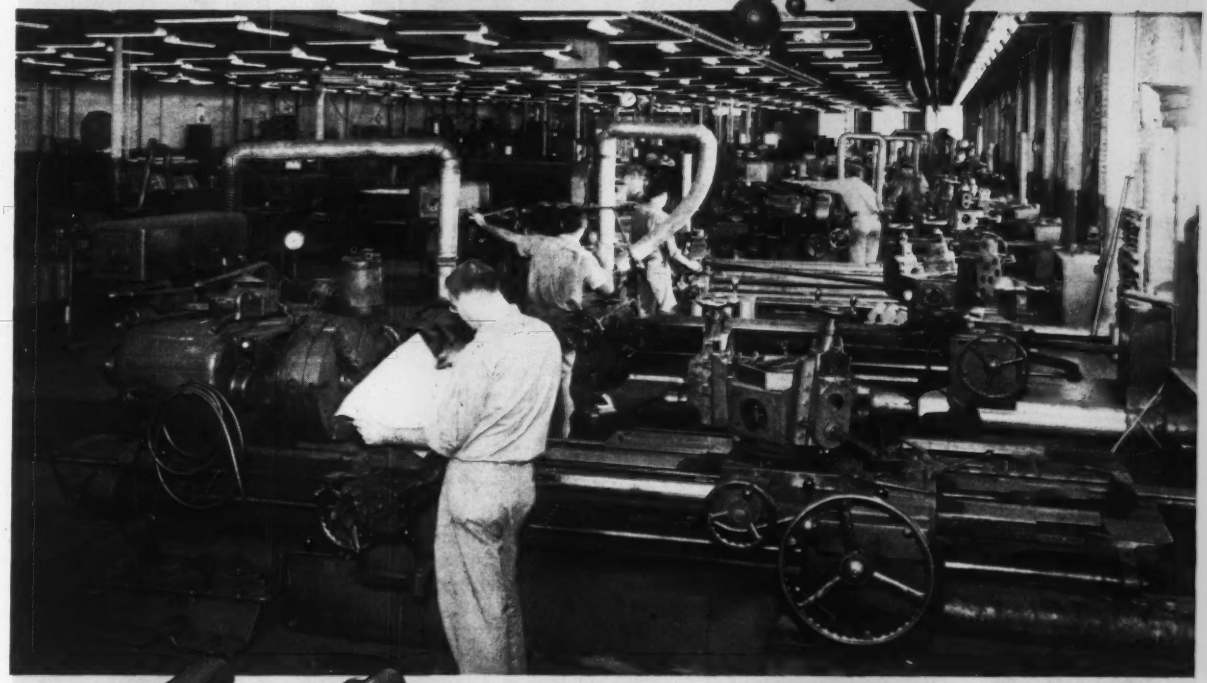

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uniform removal of specimen surfaces by ablation.

Electrical properties — Corning's fused silica has an extremely stable dielectric constant and a low loss factor over a broad temperature range. At a frequency of 8.6×10^9 cps, the dielectric constant is 3.58 at 77 F and 3.57 at 750 F. At the same frequency, dielectric loss factor ranges from 0.00069 at 77 F to 0.00098 at 750 F.

What's new IN MATERIALS

Honeycomb Core Made by Chemical Milling Technique

■ Chemical milling, discussed in a previous issue of this magazine (see *Materials & Methods*, Oct '54, p 89) has been applied successfully to the manufacture of honeycomb cores.

In chemical milling, parts are immersed in a modified hot alkaline solution which etches away the surface at a uniform rate. Areas in which no metal removal is desired are masked. Differential metal removal is achieved by stripping masks intermittently or by gradually immersing or removing the metal from the etching bath.

Cost savings

The developers, Chem-Mill Div., Turco Products, Inc., Wilmington, Calif. and Norair Div. of Northrop Corp., 1001 Broadway, Hawthorne, Calif., say that applying the process to honeycomb core promises potential savings of millions of dollars in aircraft and missile production costs.

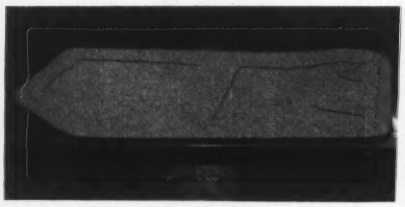
For example, the cost of a typical aircraft part, a vertical stabilizer leading edge, can be reduced from $361 by machine milling to $27 per unit. Another example is the reduction of tooling costs from $3500 to $800 in producing a 16 by 36 by ¾-in. thick landing gear strut door.

Materials, tolerances

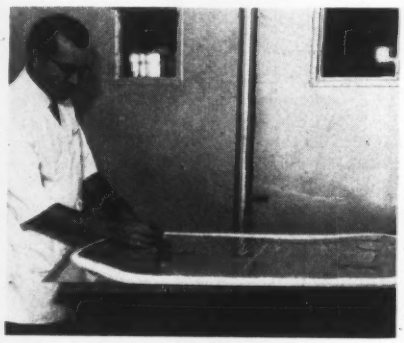
Aluminum alloy 5052 and 3002 and stainless steel 15-7 and 17-7 PH honeycomb cores have been milled successfully with the process. Application to other aluminum and steel honeycomb materials is under investigation.

Production tolerances of ±0.005 in. can be held for both aluminum and steel honeycomb cores, and special tolerances of ±0.003 in. can be held for aluminum and ±0.002 in. for steel honeycomb cores, according to the developers.

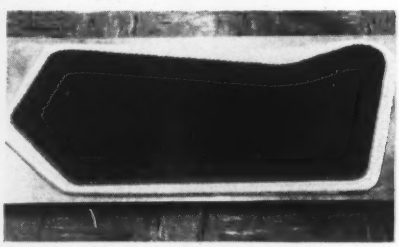
(continued on p 138)



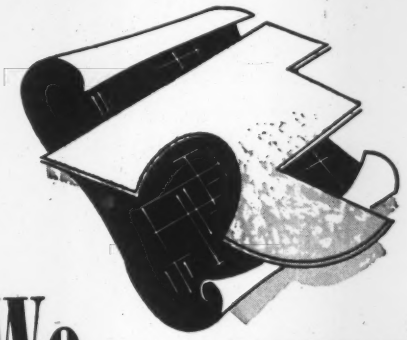
1. Plaster-like negative, *representing reverse face of desired honeycomb contour, is cast from a master honeycomb core pattern.*



2. Negative is coated *with a film of chemical resistant plastics masking compound.*



3. Honeycomb core, *still unetched, is pressed into plaster-like negative to controlled depth.*



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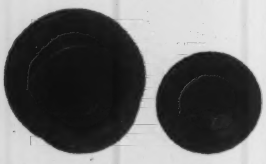
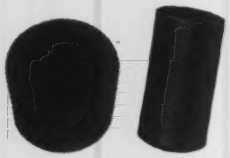


- Molds for powder metallurgy?

- Sintering boats?



- Crucibles, jigs, plates?
- Similar hot applications?

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What's new IN MATERIALS

How new process works

Briefly, the process (see photos) consists of pressing a block of expanded honeycomb into a frangible, water soluble, plaster-like "negative" representing the reverse side of the desired contour; masking the exposed portion of the honeycomb cells; dissolving the negative; and removing the exposed portion of the honeycomb by chemical milling.

Advantages

The developers say the process will permit designers wider latitude in the use of honeycomb in aircraft and missiles. The developers also say that production of difficult contours, such as inside double curvatures which are either impossible or economically unfeasible to produce by machine techniques, will be possible with the new chemical milling technique.

The chemical milling process was invented by Eldon Bowman, a research assistant in Norair's Materials Research Laboratories. It is being refined and adapted for production use by the Chem-Mill Div. of Turco Products, Inc.

Polyester-Coated Steel Sold in Continuous Coils

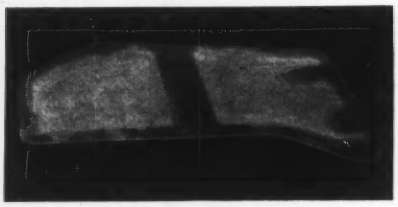
Continuous coils of polyester-coated strip steel laminated with a thin polyester film are now available from Enamelstrip Corp., 20th & Walnut Sts., Allentown, Pa. The developer says the precoated steel can be formed the same as uncoated steel.

According to the producer, the thin polyester film can be decorated in any pattern that can be photographed, and in any color. For appliances, the product can be produced in a pure white that will not fade, yellow or otherwise deteriorate in appearance. The strip can also be predecorated in more than 500 wood grain patterns for wall paneling.

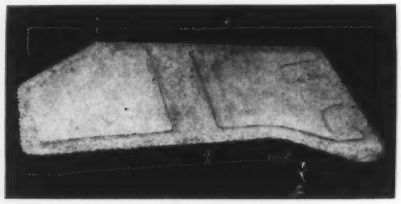
Tradenamed Miracoil, the predecorated steel is already being used for TV cabinets.

Miracoil polyester-coated steel is presently being produced in widths

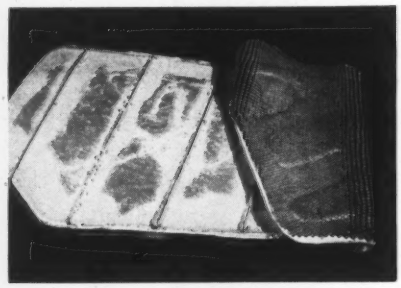
4. Exposed portion *of honeycomb block is filled with a hot-melt sealing compound to protect it from the etchant.*



5. Plaster negative *is washed away leaving unwanted portion of the honeycomb exposed.*

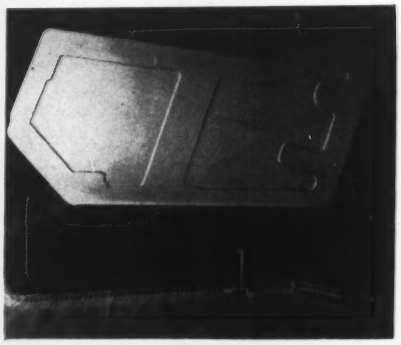


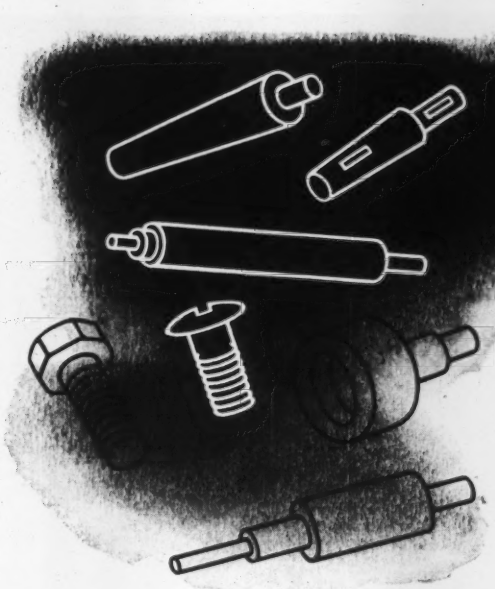
6. Contoured face *of honeycomb core is shown after chemical milling, with mask and sealer still in place.*



7. Sealer *is pulled from the honeycomb core, and mask is removed by blowing a stream of air over the honeycomb core.*

8. Completed honeycomb core *is shown with a matching aluminum skin after chemical milling.*





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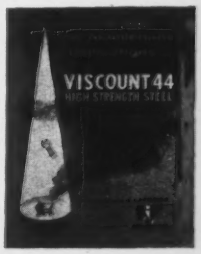

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PHILADELPHIA • PITTSBURGH • SAN LEANDRO • TOLEDO

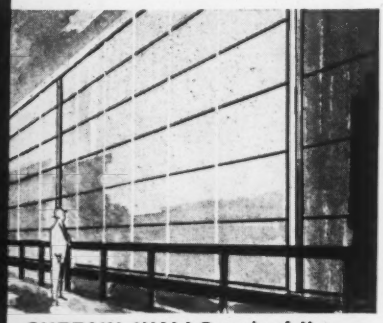
For more information, turn to Reader Service card, circle No. 487

When wear creates problems...

MET-L-WOOD®

puts beauty to stay!

COUNTERS of Met-L-Wood can be designed to fit any decorating scheme, yet stand hardest service.



CURTAIN WALLS made of Met-L-Wood panels permit *fast* construction; lend beauty and life to buildings.

MOTOR STAIRWAY and WALKWAY PANELS of Met-L-Wood stand up under constant use... help damp vibration, resist denting.

WAINSCOTING in traffic areas gets rough treatment; is a natural for decorative Met-L-Wood use: sustained beauty without upkeep.

CABINETS and enclosures of all kinds gain strength, beauty, life from Met-L-Wood.

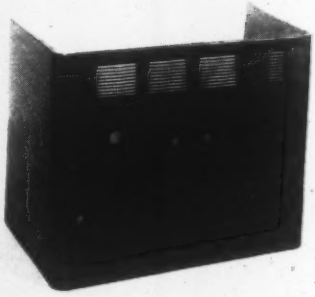
X-RAY & RADIATION ROOMS can be attractive as well as safe with lead-cored Met-L-Wood panels, doors.

Detailed data on how Met-L-Wood can serve you, in one or more of its many forms, is yours for the asking. Write for new Bulletin 522. Met-L-Wood Corporation, 6755 West 65th Street, Chicago 38, Illinois.

STRONG
DURABLE
LIGHTWEIGHT

MET-L-WOOD Metal bonded to plywood

For more information, turn to Reader Service card, circle No. 427



TV cabinet *is stamped out of polyester-coated steel strip.*

up to 32 in. New production facilities are now being completed for making a 48-in. width available to the appliance industry before the end of the year. The 48-in. width will be used as a protective-decorative wrap-around material for kitchen cabinets and refrigerators, and as predecorated wall paneling.

Potential uses

In addition to appliances and TV cabinets, the coated steel is expected to find use in the following products: movie and slide projectors, metal tubing, vending machines, air conditioning units, roof linings for trucks and buses, luggage racks for buses, business machines, bathroom enclosures, toys, tape recorders, wastebaskets, bread boxes, food trays, cameras, food canister sets and telephones.

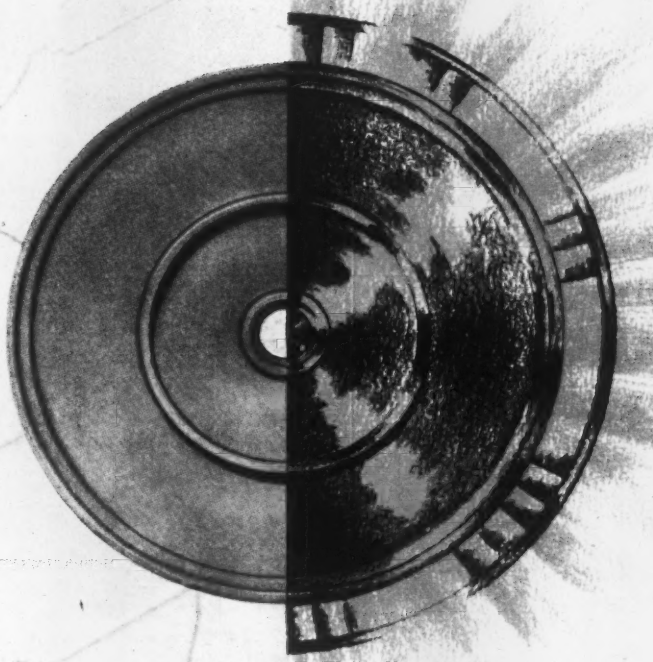
Properties

Moisture resistance—Tests show that the polyester-coated steel does not blister or delaminate after 1000-hr exposure to 97% RH at 100 F. Other tests show that the material holds up well after 115-hr immersion in water at 77 F, and after 1-hr exposure to steam.

Abrasion resistance—Miracoil specimens withstood 1500 cycles on a Taber abrasion testing machine equipped with a CS-17F wheel and 1000-gm weight.

Weather resistance — The producer says the coated steel product has shown better durability than painted and baked enamel decorative surfaces in accelerated testing programs.

Stain resistance—Tests show that



NICKEL BASE ALLOY FORGINGS

WITH

GUARANTEED PROPERTIES

FOR

IMPROVEMENTS IN

- weight
- reliability
- performance

can be accomplished with WYMAN-GORDON forgings. Optimum metallurgical practice and quality control provide higher property levels and reduced variation within and between forgings to permit generally the following GUARANTEED MINIMUM mechanical properties for contoured wheels and discs up to 50 inches in diameter.

RENÉ 41*

Typical Mechanical Properties

TENSILE PROPERTIES:	Room Temp.	1400° F
Ultimate Strength, psi	200,000	145,000
.2% Yield Strength, psi	150,000	125,000
.02% Yield Strength, psi	135,000	110,000
Elongation (% in 2")	15	18
Reduction in Area, %	18	20

STRESS RUPTURE:	Combination Smooth and Notch Bar	Smooth Bar
Temperature, ° F	1350	1650
Stress, psi	85,000	25,000
Life, Hours	100	50
Elongation, %	12	12
Reduction in Area, %	14	14

Guaranteed Minimum Mechanical Properties

TENSILE PROPERTIES:	Room Temp.	1400° F
Ultimate Strength, psi	180,000	135,000
.2% Yield Strength, psi	132,000	115,000
.02% Yield Strength, psi	120,000	100,000
Elongation (% in 2")	12	13
Reduction in Area, %	14	18

STRESS RUPTURE:	Combination Smooth and Notch Bar	Smooth Bar
Temperature, ° F	1350	1650
Stress, psi	85,000	25,000
Life, Hours	40	25
Elongation, %	8	10
Reduction in Area, %	10	12

*RENÉ 41: GENERAL ELECTRIC COMPANY

EST. 1883

PHOTO-MICROGRAPH AT X1000

Forgings of other Nickel Base Alloys with superior guaranteed properties are also available. Wyman-Gordon is prepared to serve you at the design, engineering and purchasing stages of your developments.

WYMAN-GORDON

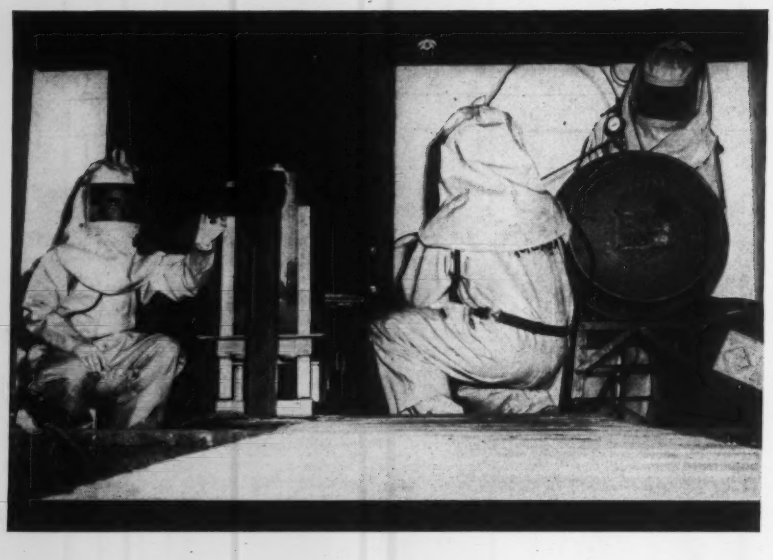
FORGINGS

of Aluminum Magnesium Steel Titanium . . . and Beryllium Molybdenum Columbium and other uncommon materials

HARVEY ILLINOIS — WORCESTER MASSACHUSETTS — DETROIT MICHIGAN

GRAFTON MASSACHUSETTS — FRANKLIN PARK ILLINOIS — LOS ANGELES CALIFORNIA — FORT WORTH TEXAS

For more information, turn to Reader Service card, circle No. 441



It costs less to **RENT**
A MATERIALS LABORATORY than to buy one

A wealth of experience in materials evaluation . . . economical, rapid instrumental analysis . . . the latest analytical techniques as they are developed . . . all these go to work on your products and materials at United States Testing Company . . . and at a fraction of what it would cost *you* to maintain a staff and facilities.

Typical Assignments cover:
Behavior of metals—Corrosion studies—Defect analysis—Photomicroscopy—Radiography—Formulation of welds—Residual defects—Thermal analysis—Ore, steel and alloy analysis—Fertilizer and soil analysis—Abrasion studies—Heat distortion—Salt spray—Thermal conductivity—Tensile properties—Electrical and physical properties of plastics—Plasticizer identification—Legal investigations.

Typical Materials and Products Evaluated:
Adhesives—Bearings—Castings—Ceramics—Concrete—Flooring Materials—Foams—Fuels—Laminates—Leather—Molding Compounds—Paper Products—Plastics—Rubber compounds—Textiles—Water repellents and others.

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of bulletin 5902 describing our materials and product evaluation facilities.

The World's Most Diversified Independent Laboratory.

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For more information, turn to Reader Service card, circle No. 394

What's new IN MATERIALS

the polyester-coated strip steel is unaffected by the following: 10% hydrochloric acid, 10% sodium hydroxide, 10% citric acid, mustard, vinegar, port wine, lemon juice, gasoline, carbon tetrachloride, cooking oil, soap, detergents, ammonia, coffee, shoe polish, moth and fly spray, beet juice, ink, iodine and phenol.

Fabrication

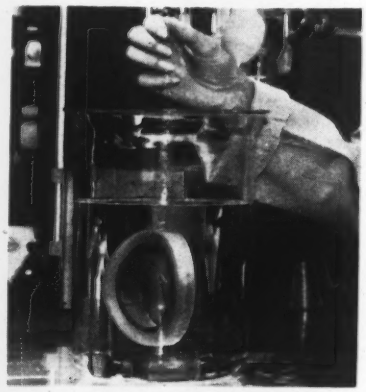
According to the producer, Miracoil can be deep drawn, lock seamed, roll formed, sheared, crimped, bent and pierced without harm to its predecorated surface. Cup tests failed to break the decorative film even after failure of the steel.

At present, the product can be joined only by mechanical means such as fasteners and crimping. However, new heat joining methods and adhesives are being explored.

How product is made

Enamelstrip Corp.'s polyester-coated steel strip is produced as follows:

1. Steel strip is cleaned, treated



Water resistant tape—The transparent tape shown here is said to retain its properties and original dimensions after immersion in water for nearly 12 months. The tape—also acid, alkali and solvent resistant—is made with a transparent vinyl film backing. It was developed by Minnesota Mining & Mfg. Co., 900 Bush Ave., St. Paul 6, Minn., and is called Scotch brand Paklon No. 681. It is supplied in widths from ¼ in. to 43 in.

NAUGATUCK PARACRIL OZO

THE OIL-RESISTANT, OZONE-RESISTANT NITRILE RUBBER

Now—the finest weather-resistant wire jackets can be *Colored!*

FOR SALES APPEAL • FOR SERVICE EASE

New Paracril OZO—a superior rubber compound developed by Naugatuck—makes possible *new eye appeal, new ease of identification.* And it outperforms standard wire jacket compounds many other ways, too!

Compare new PARACRIL OZO with other wire jacket rubbers. Prove for yourself, new PARACRIL OZO gives:

- significantly superior ozone resistance
- greater fuel and oil resistance
- much greater abrasion resistance than standard jacket compounds
- excellent processability, with particularly fast extrusion
- *permanent retention of bright colors!*

If you are not already using PARACRIL® for your wire jacket compounds or similar products requiring such properties, chances are 1000 to 1 it's because you haven't yet *tried* PARACRIL OZO.

Why *not* try it—soon. Contact your nearest Naugatuck representative at the address below.

Naugatuck Chemical

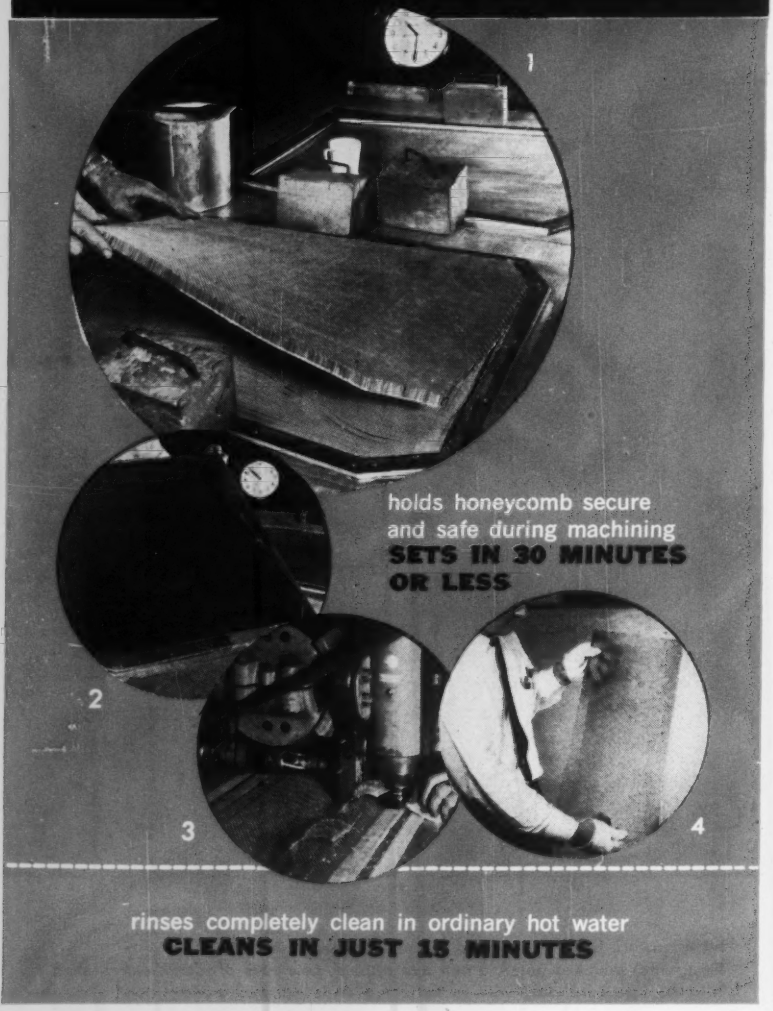
Division of United States Rubber Company 1241 P Elm Street Naugatuck, Connecticut

US RUBBER

Rubber Chemicals · Synthetic Rubber · Plastics · Agricultural Chemicals · Reclaimed Rubber · Latices · CANADA: Naugatuck Chemicals Division, Dominion Rubber Co., Ltd., Elmira, Ontario · CABLE: Rubexport, N.Y.

For more information, turn to Reader Service card, circle No. 488

Zincilate WST-200



Zincilate WST-200 sets in 30 minutes or less, "locking" the honeycomb section securely and safely in position for machining. In 15 minutes or less, every trace of WST-200 is rinsed away in a simple hot water dip, leaving the honeycomb spotlessly clean, ready for perfect brazing.

Zincilate WST-200, honeycomb hold-down coating, is one of several specialized coatings developed exclusively by Industrial Metal Protectives, Inc. For complete information, write, outlining your requirements for hold-down, corrosion-resistant, scratch-resistant, permanent or temporary coatings. If desired, samples and engineering assistance can be provided.

PROTECTION that SELLS your PRODUCTS

INDUSTRIAL METAL PROTECTIVES

414 Homestead Ave. • Dayton 8, Ohio • BAldwin 2-6747, 2-6748

For more information, turn to Reader Service card, circle No. 433

and dried.

2. Strip is preheated.

3. Preheated polyester resin is applied to the strip. A clear or pigmented adhesive is applied to the polyester coating either on one or both sides in the same color and thickness, or in different colors and thicknesses.

4. The coated metal is cured at temperatures ranging from 300 to 600 F.

5. A very thin polyester decorative film is applied to the coated strip. The film may be used clear or printed with any type of pattern that can be photographed.

6. The coated strip is quickly cooled to a temperature just below freezing.

Coating Prevents Scale During Heat Treatment

A new coating, composition of which has not been revealed, is said to prevent scale formation on stainless steel, copper alloys, nickel-chromium alloys and cobalt alloys during heat treatment. The coating, called Skalix, was developed by Navan Products, Inc., 900 N. Sepulveda St., El Segundo, Calif.

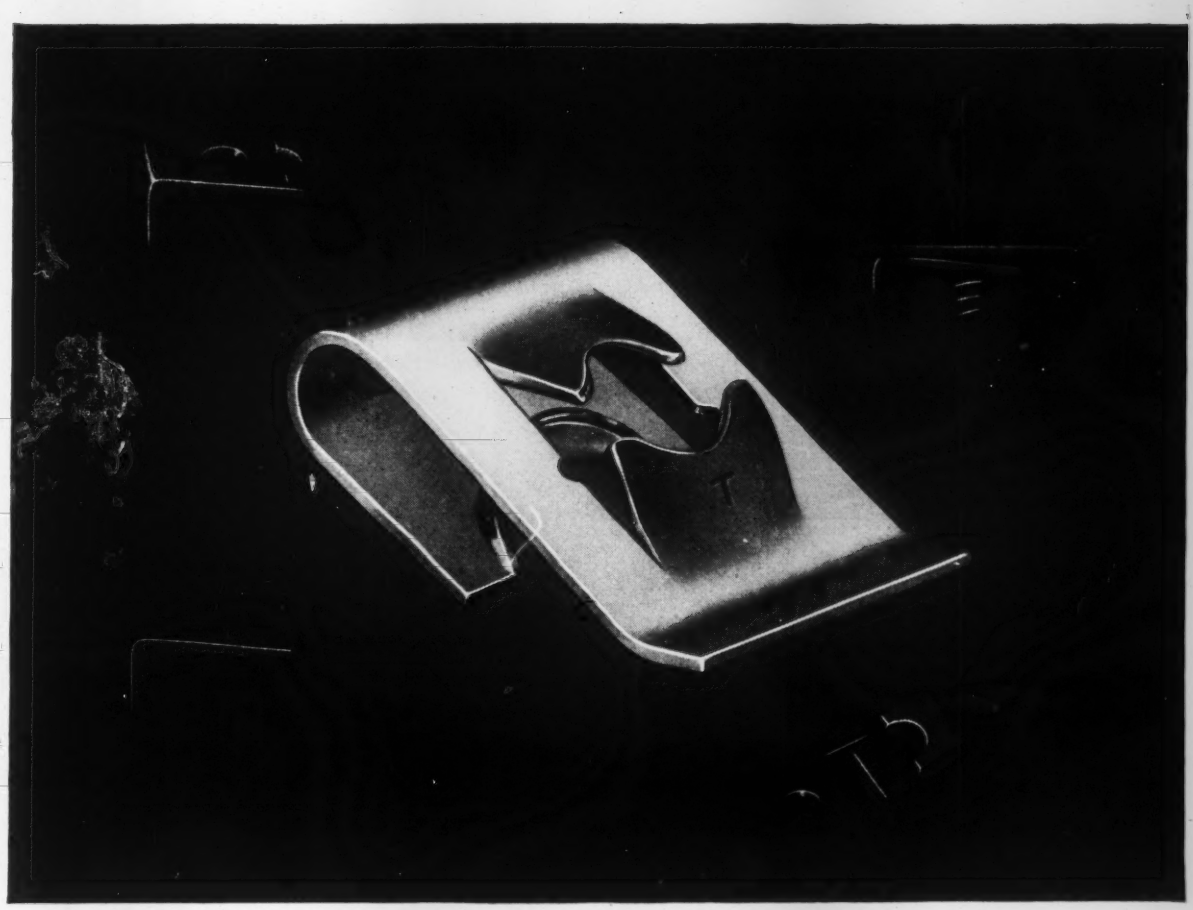
The coating, applied by spraying or dipping, adheres to metal at furnace temperatures, forming an oxygen-tight seal. As metal cools, the coating "pops off" by itself. Thus, the coating makes inert gas atmospheres unnecessary.

A gallon of the coating is said to cover approximately 1500 sq ft of metal surface.

Modified Phenolic Strong at 600 F

A silane-modified phenol formaldehyde resin, said to retain its strength after exposure to temperatures up to 600 F for hundreds of hours, is available in commercial quantities from Monsanto Chemical Co., Plastics Div., Springfield 2, Mass.

The new material, called Resinox SC-1013, was developed especially for use with fiberglass and asbestos reinforcements to make radomes for supersonic aircraft. Because of its



Another Tinnerman Original...

Self-retaining "U" and "J" SPEED NUTS® cut assembly costs up to 50% or more!

If you are worried about rising assembly costs, let one-piece "U" and "J" SPEED NUTS keep costs down . . . and improve your product.

They can't fall off, once they've been pressed into screw-receiving position. No welding, staking or other secondary fastening devices needed. You eliminate lock washers—spring steel SPEED NUTS are self-locking, make vibration-proof attachments.

SPEED NUTS are ideal for blind assembly or hard-to-reach locations. Apply them *before* you paint panels without danger of paint-clogging. Or *after* porcelainizing, without damage to finishes. The "U" type is similar to the "J" type, shown above, but is used where full bearing surface on the lower leg is required.

A free Fastening Analysis can tell where SPEED NUT brand fasteners belong on your products. Call your Tinnerman representative—he's listed in most major telephone directories. Or write to:

TINNERMAN PRODUCTS, INC.
Dept. 12 • P. O. Box 6688 • Cleveland 1, Ohio

TINNERMAN
Speed Nuts®

FASTEST THING IN FASTENINGS®

CANADA: Dominion Fasteners Ltd., Hamilton, Ontario. GREAT BRITAIN: Simmonds Aerocessories Ltd., Treforest, Wales. FRANCE: Simmonds S. A., 3 rue Salomon de Rothschild, Suresnes (Seine). GERMANY: Nocano-Bundy GmbH, Heidelberg.

For more information, turn to Reader Service card, circle No. 425

How Fansteel 77 Metal PLUS Fansteel Engineering

added up to a $10,000 Saving!

Fansteel does more than just talk "customer savings." Take the case of these Fansteel 77 Metal contour parts, ¾" thick x 9½" high x 15" developed length with a radius of 9".

Fansteel engineers developed new fabrication techniques which cut the cost 30% over former methods of producing the part. To the customer this added up to a $10,000 saving on this one order alone.

It's just one more example of how the constant search by Fansteel engineers for cost-cutting ways of fabricating Fansteel metals, pays off in big savings for the customer.

Investigate the possibilities of similar savings on your parts... whether it's made from 77 metal, tantalum, molybdenum, columbium or tungsten. Call in the Fansteel man.

NEED A METAL 50% HEAVIER THAN LEAD?

Fansteel 77 is a metal produced especially for applications requiring maximum density in limited space. It is twice as heavy as steel, 50% heavier than lead, yet—much stronger than cast iron. Non-magnetic 77 Metal is easily machined and easily joined to other metals. Furthermore, it is **non-toxic** and **non-radioactive** requiring no special precautions in handling. Available in finished or semi-finished parts to your specifications or in bars, rods, rings, disks, special shapes.

K598A

FANSTEEL

Fansteel Metallurgical Corporation
North Chicago, Illinois, U.S.A.

For more information, turn to Reader Service card, circle No. 474

PROPERTIES OF RESINOX SC-1013 LAMINATES

MECHANICAL PROPERTIES[a]	
Tensile Strength, psi	
Room Temperature	46,000
½ Hr at 500 F	43,000
100 Hr at 600 F	23,000
Flexural Strength (flatwise), psi	
Room Temperature	74,000
½ Hr at 500 F	63,000
100 Hr at 600 F	37,000
200 Hr at 600 F	23,000
Compressive Strength (edgewise), psi	
Room Temperature	51,000
½ Hr at 500 F	37,000
½ Hr at 600 F	28,000
100 Hr at 600 F	8,240
Modulus of Elasticity, 10^6 psi	
Room Temperature	3.72
½ Hr at 500 F	3.35
100 Hr at 600 F	2.02
200 Hr at 600 F	1.48
ELECTRICAL PROPERTIES[b]	
Dielectric Constant	
Room Temperature	5.10
212 F	5.25
500 F	5.48
Dissipation Factor	
Room Temperature	0.0234
212 F	0.0267
500 F	0.0212

[a] ⅛-in. thick glass cloth laminates.
[b] ¼-in. thick glass cloth laminates.

excellent performance in the 500 to 600 F temperature range, the resin is expected to be used in other applications where such temperatures have prohibited the use of plastics.

According to the producer, Resinox SC-1013 has high frequency electrical properties many times better than those of conventional phenol formaldehyde resins.

Seamless Tubing for Heat Exchangers

New seamless tubing available from Superior Tube Co., 1548 Germantown Ave., Norristown, Pa. includes small columbium, tantalum and vanadium tubing, and nuclear-quality stainless steel heat exchanger and fuel element tubing.

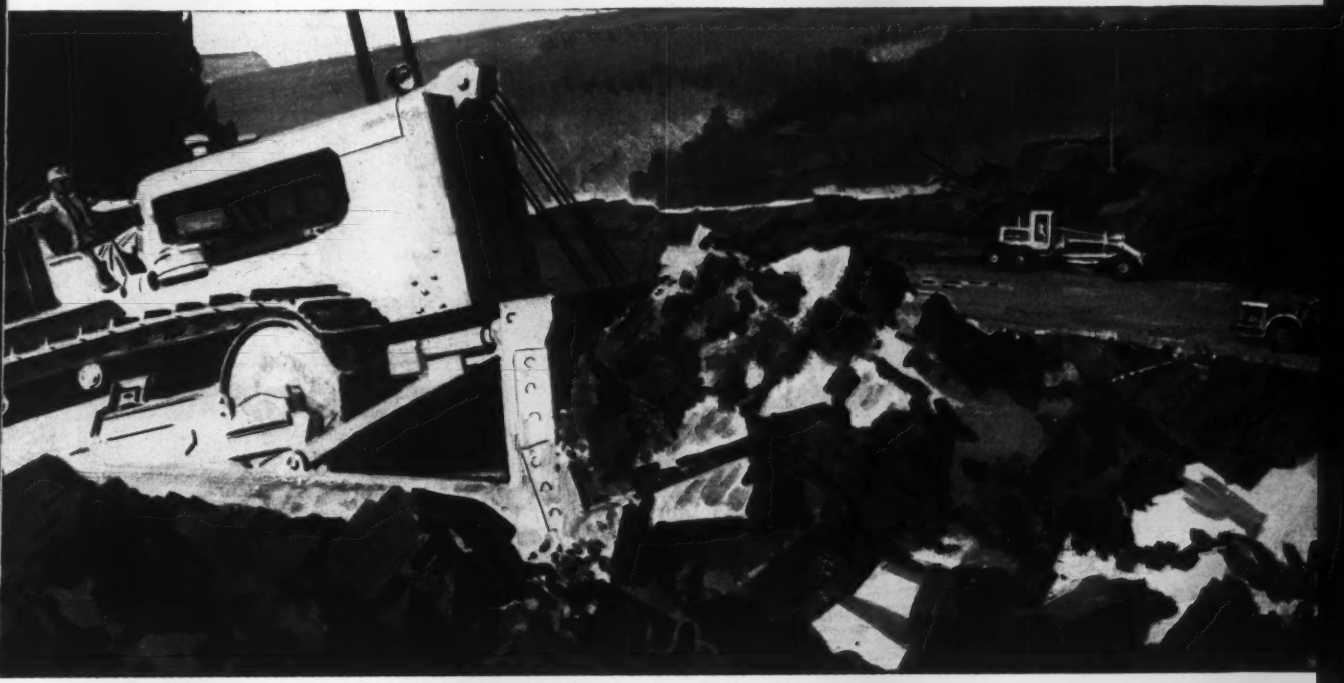
1. Columbium, tantalum and vanadium tubing

Superior's columbium, tantalum and vanadium tubing is available in the fully annealed, half-hard drawn and full-hard conditions. Sizes of

Earthmoving muscles from tubes of steel

A construction site springs to life as earthmoving equipment tugs, scoops, heaves and rips away at the earth's skin. It's grueling work!

That burly dozer. It's precision built! It's strong! Its massive blade can tear the side out of a hill. Yet, it's nimble, too. In spite of a crab-like figure, it can stop with a jolt, back off, spin, dig in and charge with the force of a galloping rhinoceros.



Power is jammed into these machines. That's why they're built with the toughest, most durable materials in the world. For years, leading manufacturers have chosen USS National Seamless Mechanical Steel Tubing for hydraulic cylinders, tractor pins, bushings and more than 100 other vital parts in earthmoving, rockmoving, grading and all types of heavy mobile equipment. *Why?* Because National Seamless Tubing is ideal for the fabrication of machine parts subject to bruising performance and long wear.

USS National Seamless Mechanical Steel Tubing is another product from the world's largest manufacturer of tubular materials. For more than 80 years, National Tube has been foremost in building and industrial pipe applications. For more information, write to National Tube Division, United States Steel, 525 William Penn Place, Pittsburgh 30, Pa.

USS and National are registered trademarks

USS

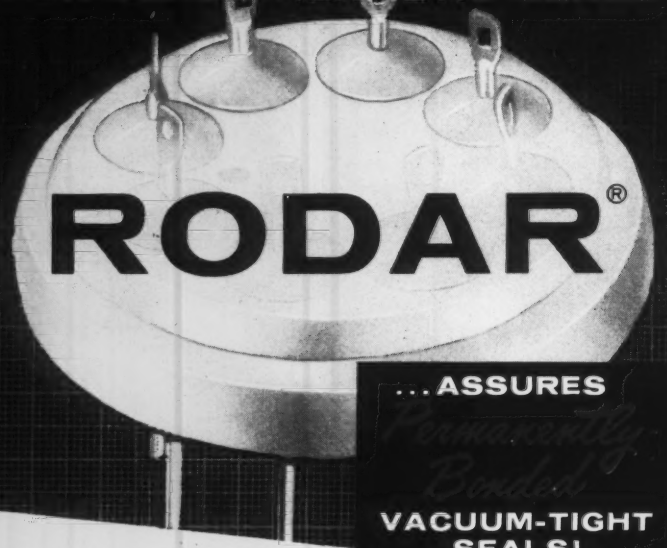
National Tube Division of United States Steel

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors
United States Steel Supply Division
United States Steel Export Company, New York

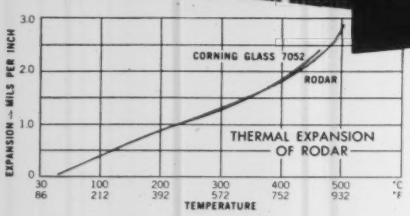
For more information, turn to Reader Service card, circle No. 388

THE Specialty ALLOY
FOR GLASS HERMETIC SEALS

RODAR®



...ASSURES Permanently Vacuum-Tight SEALS!



Another Special Alloy for a Specific Purpose

This precision alloy was developed for sealing metal to hard glass. Wilbur B. Driver Rodar is processed from melting to finished size in our own plant under the strictest controls to insure consistent analysis, temper, uniform grain size and conformance to customers' specifications. The superior stamping and sealing properties of Rodar make it *the preferred sealing alloy.*

Rodar produces a permanent, vacuum-tight seal with simple oxidation procedure and resists attack by mercury. Readily machined and fabricated, Rodar can be welded, soldered or brazed. Available in wire, strip and bar to your specifications.

PROPERTIES

Composition (Nominal)
Nickel 29%
Cobalt 17%
Manganese 30%
Iron . . . . . Balance

Melting Point
. . 1450°C. (Approx.)

Specific Gravity. . 8.36

Weight Per Cubic Inch
. . . . . .302 lb.

Electrical Resistivity
. . . 294 Ohms C.M.F.

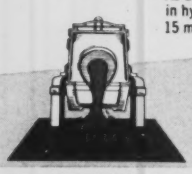
Tensile Strength
. . . . . 80,000 PSI

Hardness
. . . . 82 B Rockwell

Elongation
30% (2" gauge length)

Temperature Range	Average Thermal Expansion, *Cm/Cm/°Cx10-6
30° To 200 C.	4.33 To 5.30
30° To 300 C.	4.41 To 5.17
30° To 400 C.	4.54 To 5.08
30° To 450 C.	5.03 To 5.37
30° To 500 C.	5.71 To 6.21

*As determined from cooling curves, after annealing in hydrogen for one hour at 900°C. and for 15 minutes at 1100°C.



WILBUR B. DRIVER CO.
NEWARK 4, NEW JERSEY

IN CANADA: Canadian Wilbur B. Driver Company, Ltd., 50 Ronson Drive, Rexdale (Toronto)

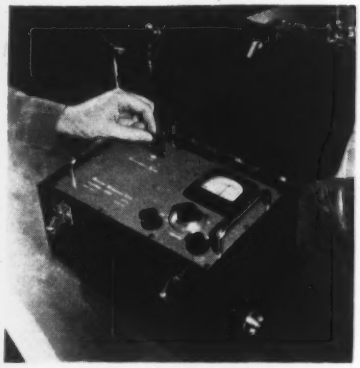
For more information, turn to Reader Service card, circle No. 428

What's new IN MATERIALS

the seamless tubing range from 0.012 to 0.125 in.

Columbium—The most promising applications for columbium tubing are in the nuclear field. Its moderately low neutron absorption makes it highly suitable for fuel element cladding, and its excellent resistance to water, liquid metals and molten salts makes it useful for reactor coolants.

Columbium has low electrical and thermal conductivity. Its principal disadvantage, in pure form, is that it oxidizes at temperatures above 2000 F. Superior says it is working with suppliers of the primary metal to develop columbium alloys that are ductile enough to be fabricated into small diameter tubing and at the same time have improved strength and oxidation resistance at

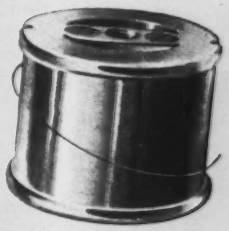


How clean is clean?—The tester shown here measures cleanliness of materials. The instrument was developed by the Graham Research Laboratories of Jones & Laughlin Steel Corp. and built by Branson Ultrasonic Corp., 40 Brown House Rd., Stamford, Conn. under a licensing arrangement. The device assigns numerical values for surface cleanliness where nonbonded soils are involved. These cleanliness values can be used to compare various cleaning techniques and equipment, to evaluate effectiveness of cleaning agents, and to determine the working life of detergents and solvents. "Cleanability" of various materials is found by successive tests on the same area of a given sample. The number of cleaning cycles needed to remove all contaminants indicates soil tenacity.

SYLVANIA Precision-Plated WIRES

Type of Wire*	Standard Percentage of Plating	Typical Applications	Sizes, in Stock or in Process
NICKEL PLATED BRONZE	2, 4%	Extensively used in manufacturing wire cloth for Fourdrinier papermaking machines and other applications where corrosion resistance is essential	.008" to .050"
NICKEL PLATED BRASS	2, 4%	Woven wire cloth for less severe service than nickel plated bronze	.010" to .050"
NICKEL PLATED COPPER	10%	Incandescent lamp lead wires. High temperature cables for service up to 650°F.	.005" to .100"
NICKEL PLATED COPPERWELD	2, 4, 8%	Lead wires for electronic tubes and incandescent lamps. Combines strength, high conductivity and oxidation resistance.	.020" to .040"
NICKEL PLATED STEEL	2, 4, 8% (Base metal contains .06% carbon nominal)	Fluorescent lamp and electronic tube leads; grid side rods; high-temperature appliance lead-in wires for operating temperatures up to 500° F.	.005" to .050"
NICKEL PLATED INGOT IRON	2, 4, 8% (Base metal, .03% carbon max.)	Lead wires and grid side rods	.015" to .050"
NICKEL PLATED IRON	2, 4, 8% (Base metal, .06% carbon max.)	Lead wires and grid side rods	.010" to .050"
SILVER PLATED "D" NICKEL SILVER PLATED PERMANICKEL GOLD PLATED "D" NICKEL GOLD PLATED PERMANICKEL	5% 5% 4, 5, 6% 4, 5, 6%	All of these used for lateral grid wires in electronic tubes	.0015" to .020" .0015" to .020" .0015" to .020" .0015" to .020"

*Partial list. 25 types in stock or in process at all times.



- Most uniform plating obtainable
- Most complete line available

PLATED WIRES are normally plated at a size only slightly larger than finished size. In the Sylvania process, a ¼" rod is plated to the desired percentage (1% to 15% plating material) and the plated rod is then drawn to the required wire diameter. This process insures maximum uniformity.

The Sylvania process results in maximum uniformity, improves the physical characteristics and increases the density of the plated metal, providing maximum protection to the core material. Sylvania Plated Wires are processed and inspected to assure compliance with customer specifications for uniformity and reliability.

Sylvania engineers are available to aid you in the establishment of your purchase specifications on both standard and special plated wires. Samples of standard products are available for your evaluation. As specialists in plated, clad and alloy wires . . . the most complete line in the industry . . . Sylvania can offer an objective recommendation on the type of wire best suited to your needs. Write for literature today.

SYLVANIA GENERAL SYSTEM

Subsidiary of

GENERAL TELEPHONE & ELECTRONICS

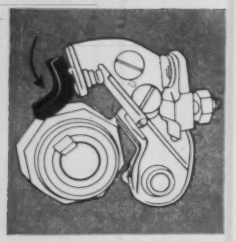
PARTS DIVISION

Custom Molded Plastics
Custom Metal Stampings
Custom Welded Parts
Custom Assemblies
Alloy, Clad, Plated Wire
Plated Metal Strip
Electronic Components
Fluorescent Components

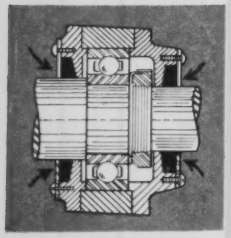
For more information, turn to Reader Service card, circle No. 412

How
FELT
BY FELTERS
Can Improve Product
SEALING and LUBRICATION

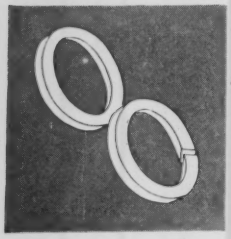
DuFelt is a laminated combination of Felters' felt and Hycar; and is recommended for sealing of lighter oils when no head exists. Seals and lubricates at the same time; and offers improvements over other materials.



Felt is an ideal wicking and lubricating material which can be designed into special assemblies like this distributor cam shown here. Lubrication is constant, wear reduced, and felt can be shaped to cover all required areas.



Lifetime bearing lubrication is now possible by selection of correct SAE grade, and designing into sealed bearing. Felt filters out contamination and works as combined reservoir and wick, directing oil flow to required areas.



Mechanical felt seals permit a close seal without undue pressure. Felt can be waterproofed and provides superior grease and oil retaining and dust, dirt and grit exclusion.

To help you get the most out of FELT, send for the Felters' Design Book. Write, today.

Ask for **FELT** *from . . .*
The **FELTERS** Co.
220 SOUTH STREET
BOSTON 11, MASSACHUSETTS
Pioneer Producers of Felt and Synthetic Non-Woven Fabrics

PE 9-18

For more information, turn to Reader Service card, circle No. 392

What's new IN MATERIALS

high temperatures.

Tantalum—The outstanding property of tantalum tubing is its excellent corrosion resistance, particularly to acids. It has been fabricated into heat exchangers, condensers, and coils used in the chemical industries for handling chlorine, chlorides, and hydrochloric and nitric acids.

Vanadium — Vanadium tubing, promising for nuclear equipment, has good resistance to almost all acids and alkalis, and electrical resistivity exceeding that of most metals. The metal has a density approximately two-thirds that of columbium and a strength-weight ratio approximately equal to that of type 304 stainless steel. These properties indicate possible use in structural parts.

2. Stainless steel tubing

The stainless steel heat exchanger and fuel element tubing are said to be the first two grades of nuclear-quality tubing made to published standards. The standards cover stainless types 304, 304L, 316, 347 and 348. The heat exchanger and fuel element tubing are available in the fully annealed condition.

Both types of tubing are made from raw stock with closely controlled chemical composition. Maximum limits are set for the carbon, manganese, phosphorus, sulfur and silicon contents of all five types of stainless steel and for the tantalum content of type 348 stainless steel. The fuel element tubing is made from tube hollows with maximum copper, molybdenum, cobalt and boron specified.

Heat exchanger tubing is produced to commercial tolerances, unless otherwise specified, and fuel element tubing is generally produced to one-half commercial tolerances.

Nickel Cathode Alloy Gives Long Tube Life

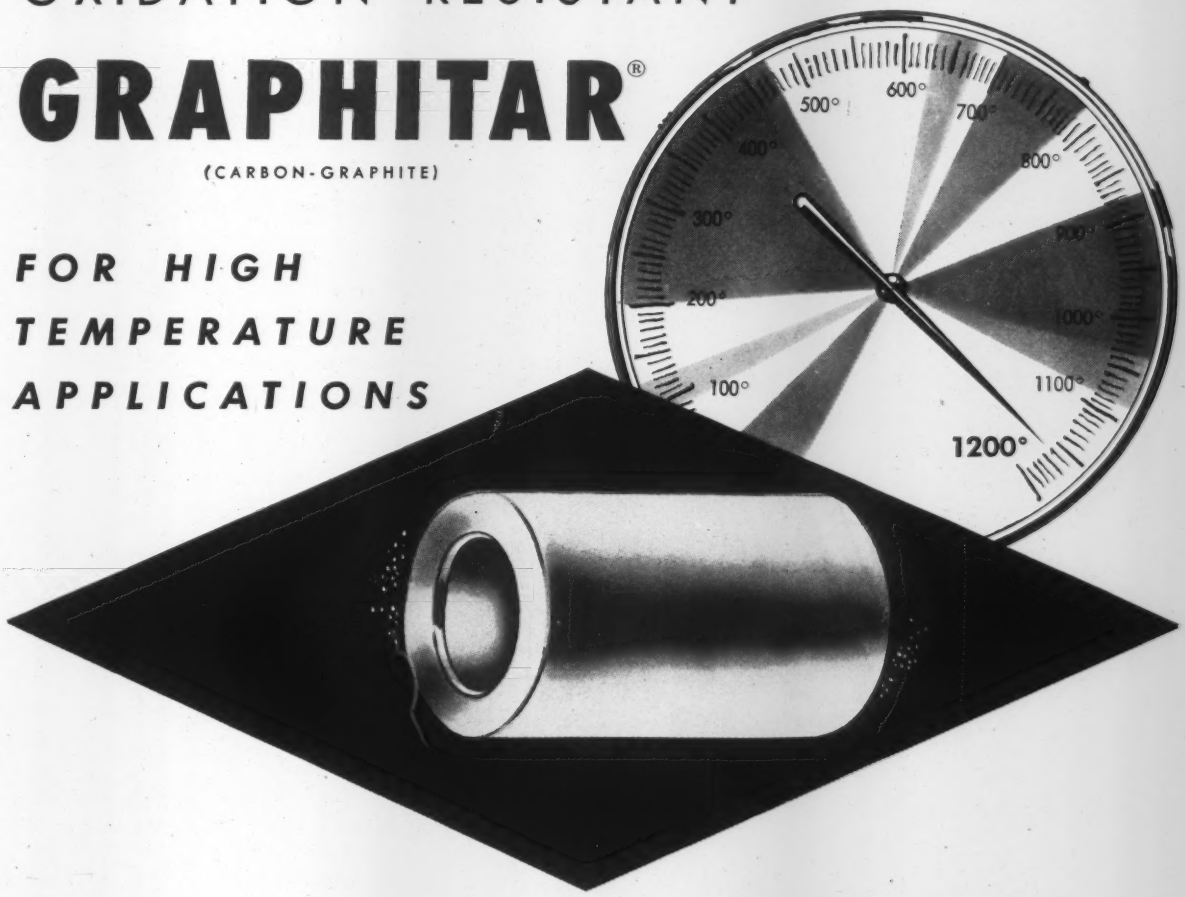
In addition to the seamless tubing mentioned above, Superior Tube Co. has introduced a new, nickel-base cathode alloy that is said to combine the excellent electron emission characteristics of active cathode alloys

ANNOUNCING A NEW OXIDATION RESISTANT

GRAPHITAR®

(CARBON-GRAPHITE)

FOR HIGH TEMPERATURE APPLICATIONS



Culminating five years of intensive research, engineers of The United States Graphite Company have developed a new oxidation resistant GRAPHITAR. In exhaustive tests, GRAPHITAR parts were exposed in an oxidizing atmosphere (air) at 1200 degrees F and after 200 hours, the GRAPHITAR showed a weight loss of less than six percent!

GRAPHITAR, which is available in many grades, is a versatile engineering material with unusual and outstanding properties that make it ideal for tough applications. It is non-metallic, resists chemical attack, has self-lubricating properties and a low coefficient of friction. It is mechanically strong, lighter than magnesium and is the perfect material for packing rings, pressure joint seals, clutch release bearings, fluid coupling seals, piston rings, pump liners and vanes.

For more information on this new oxidation resistant GRAPHITAR and its applications, write the GRAPHITAR product manager on your company letterhead.

R-279-1

THE UNITED STATES GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION, SAGINAW 3, MICHIGAN

GRAPHITAR® CARBON-GRAPHITE • GRAMIX® POWDER METALLURGY • MEXICAN® GRAPHITE PRODUCTS • USG® BRUSHES

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range panels of Lancaster glass add sales appeal, beauty and utility
For the designer, glass is a truly dynamic material. It offers low tooling cost, an unlimited range of colors, and wide fabricating flexibility. Its sanitary, heat-resistant characteristics mean brighter living, easier housekeeping for the homemaker.
Your product, too, will benefit from Lancaster's design facilities. For informative catalog, phone OLive 3-0311 or write Lancaster Glass Corporation (formerly The Lancaster Lens Company), Lancaster 7, Ohio.
Lancaster glass
to brighten your product's future.
For more information, turn to Reader Service card, circle No. 426

with the low interface impedance and low sublimation rate of passive alloys.

This combination of properties, said to give long tube life even under conditions of high current and overvoltage abuse, is achieved by adding 0.1% zirconium as the primary and 2% tungsten as the secondary reducing agent to the nickel-base alloy.

The alloy, designated X-3012, is offered by Superior in the form of seamless, welded and drawn, disk, lockseam and lapseam cathodes for vacuum tubes.

Function of zirconium, tungsten

The developer says the zirconium in the nickel-base alloy has excellent reducing potential, producing heavy electron emission and rapid activation of the cathode. Tungsten, on the other hand, stabilizes the emission characteristics when heater voltage varies and, because of its slower rate of diffusion to the coating on the cathode, supplements the reducing power of the zirconium after the cathode has been operated for an extended period.

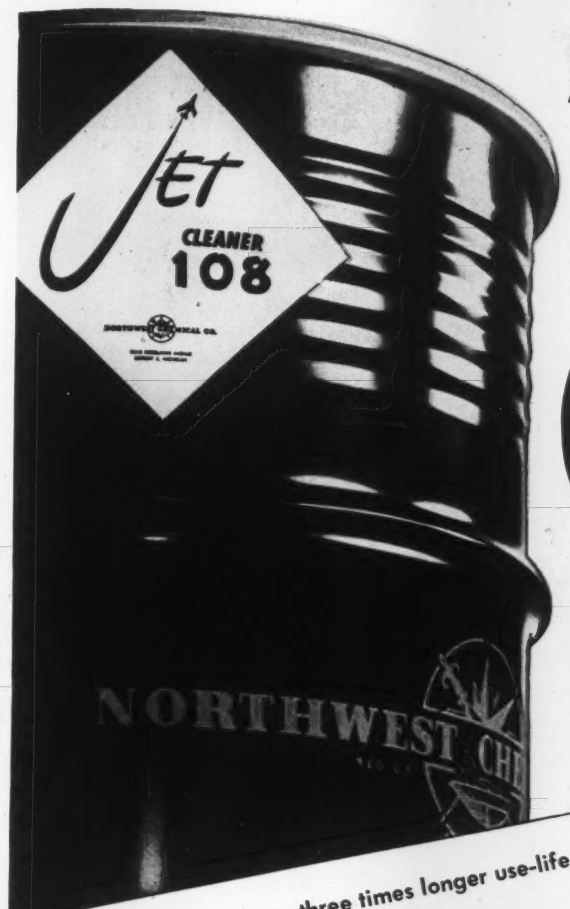
The combination of zirconium and tungsten is said to impart to alloy X-3012 a hot strength twice that of ordinary nickel alloys without these additives. Cathodes made from the alloy can be fired at 1300 F without undue softening, compared to 1100 F maximum firing temperature for cathode alloys containing no tungsten. According to the developer, the high strength of alloy X-3012 cathodes at operating temperatures permits their use in vacuum tubes subject to vibration and other damaging influences.

Glass-Base Laminates for Electrical Use

Three new plastics laminates—a polyester-glass laminate and two epoxy-glass laminates — have been developed for use in a variety of electrical applications.

1. Polyester-glass laminate

Glastic Corp., 4321 Glenridge Rd., Cleveland 21, Ohio has introduced a track resistant polyester-glass laminate for use in electrical apparatus operating in dust laden and



ANNOUNCING JET 108

AN EXTREMELY LOW-FOAMING GENERAL USE SINGLE OR MULTIPLE STAGE SPRAY CLEANER FOR BETTER RESULTS AT LOWER COST!

- Gives up to three times longer use-life than competitive products.
- Better cleaning through unusually potent penetrants, surfactants and dispersing agents.
- Carries heavy dirt load without redeposition.
- Higher the concentration, lower the foaming.
- For use on all ferrous and non-ferrous metals except aluminum.
- Used at 100° to 140°F temperatures.
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- Ideal for use following soak cleaners.
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- Non-Toxic, dustless, non-caking.
- No disposal problem.

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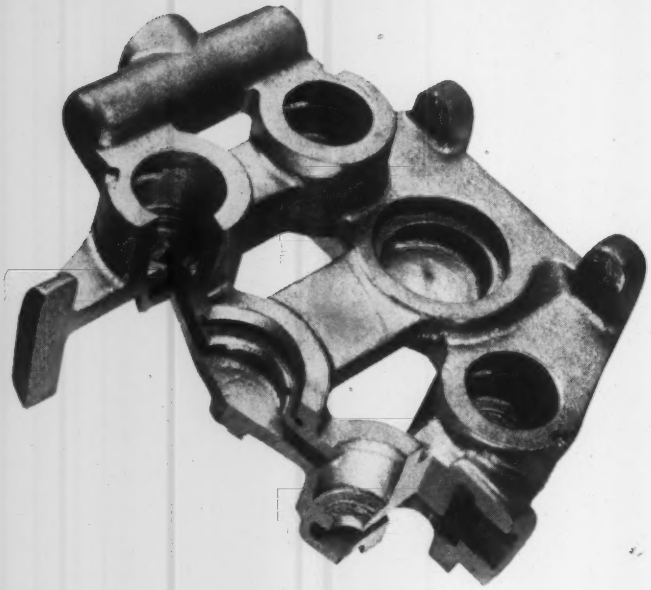
NORTHWEST CHEMICAL COMPANY

9310 ROSELAWN DETROIT 4, MICHIGAN

For more information, turn to Reader Service card, circle No. 423



CAUSTIC SOLUTION

A CASE IN POINT—This is a 19 pound Ni-Resist valve body designed to handle caustic fluids at 400 psi. It was cast for the John Bean Division of Food Machinery & Chemical Corp. Ni-Resist is ideal for this application because it combines high corrosion resistance with superior resistance to erosion from high velocity fluids.

The intricate coring required demands unusual skill to produce Ni-Resist castings leak-proof at 400 psi operating pressures. Hamilton Foundry succeeded in producing pressure tight castings, an accomplishment difficult for the best of foundrymen.

When new and unusual design problems arise in the selection of metal and the casting of parts, you will find that the skill and integrity of your foundry is your best insurance that specifications—and delivery schedules—will be met.

GRAY IRON • ALLOYED IRON • MEEHANITE® • DUCTILE (NODULAR) IRON • NI-RESIST • DUCTILE NI-RESIST • NI-HARD

HAMILTON FOUNDRY INC.

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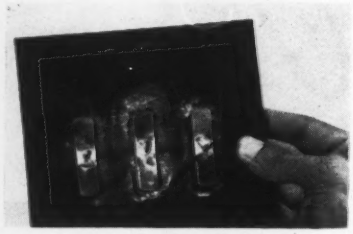


Polyester-glass laminate *shows no carbon tracking after testing in compliance with a new, proposed ASTM test.*

humid atmospheres. The developer says track resistance of the new laminate, called Grade UTR Resistrac, is conservatively rated with a 200-hr value as established under a proposed ASTM dust-fog track resistance test. Glastic says this value represents several years service under the most adverse environmental conditions.

In the proposed ASTM test, a specimen is coated with an artificial dust containing flint, clay, salt and paper. The specimen is placed in a chamber and sprayed with water. An electrical charge of 1500 v is applied between two electrodes placed 1 in. apart on the surface of the specimen. Arcing between the electrodes produces high temperatures in the material which may cause carbon tracking. Materials are rated by the time required for the arcing to form a conductive carbon path between the electrodes.

A general purpose polyester-glass laminate failed by carbon arcing in less than 5 hr and a glass-phenolic laminate failed in less than 1 hr in the proposed ASTM test.

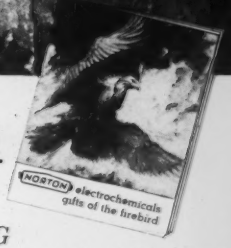
Glastic's new polyester-glass laminate is available in standard sheet sizes of 36 by 72 in. and 24 by 36

PROPERTIES OF RESISTRAC LAMINATE

MECHANICAL PROPERTIES	
Ten Str, psi	10,000
Compr Str (flatwise), psi	30,000
Flex Str, psi	18,000
Shear Str, psi	10,000
Impact Str (Izod), ft-lb/in.	8.0
ELECTRICAL PROPERTIES	
Dielec Str, v/mil	400
Power Factor (60 cps)	0.060
Arc Res, sec	120

The legendary Firebird, the Phoenix, rose young and strong again and again from flames . . . This is the new Norton Firebird — symbol for the exciting new fused materials made in Norton's electric furnaces.

OXIDES: gifts of the Firebird



From the white hot caldrons of huge electric furnaces at Norton Company come OXIDES with capabilities hardly less miraculous than those of the Phoenix itself.

In furnace flames ZIRCONIUM OXIDE develops properties which make it useful as a metallurgical and chemical source material, a thermal insulator, and as a basic material for high temperature refractories and heating elements. Aluminum oxide evolves into high purity versatile ALUNDUM FUSED ALUMINA: and MAGNORITE FUSED MAGNESIA attains its outstanding value as a high temperature electrical insulator.

These Norton furnaces also produce other oxides widely used in research and development and now finding production applications: fused diopside, mullite, dolomite, spinels . . . chromic oxide and lime. There are *hundreds* of applications for Norton OXIDES. Learn how they can improve *your* product quality and processing efficiency.

Gifts of the Firebird: compounds of silicon • zirconium • boron • aluminum • magnesium • titanium • chromium . . . including many borides • carbides • nitrides • oxides

FREE CATALOG

For a complete list, with detailed descriptions, write for the new booklet, *Norton Electrochemicals . . . Gifts of the Firebird* to NORTON COMPANY, Electro-Chemical Division, 961 New Bond St., Worcester 6, Mass.

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- Sheet Formed Plastics Parts
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ELECTRICAL PROPERTIES OF GB-16EV-2 LAMINATE

Dielec Str (perp), v/mil	600
Dissip Factor (1 mc)	
Cond A	0.020
Cond D48/50	0.023
Dielec Const	
Cond A	4.71
Cond D48/50	5.01
Arc Res, sec	130
Vol Res (Cond C96/35/90), megohm-cm	2.4 x 10^7

in., in thicknesses ranging from ⅛ through ¾ in.

2. Two epoxy-glass laminates

Continental-Diamond Fibre Co., Newark 25, Del. has introduced two general purpose epoxy-glass laminates for electrical insulation applications under severe service conditions. The laminates, designated GB-28EV-2 and GB-16EV-2, are similar except that GB-16EV-2 is made from a finer weave cloth, permitting its use in thinner laminates. Both laminates are available plain or as copper-clad sheets for printed circuit applications. They are supplied in sheet sizes of 38 by 42 in. and 38 in. square.

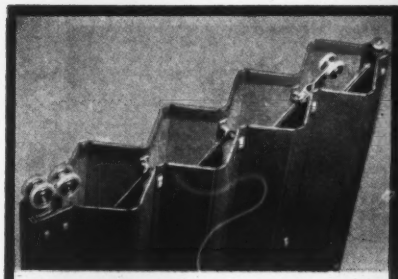
Method Prints Circuits Directly on Ceramics

A new method for producing printed wiring directly on ceramics without the use of adhesives has been developed by Bell Telephone Laboratories, 463 West St., New York 14. The basis of the process, which uses standard silk screening techniques for forming the pattern, is a specially formulated copper-bearing paste.

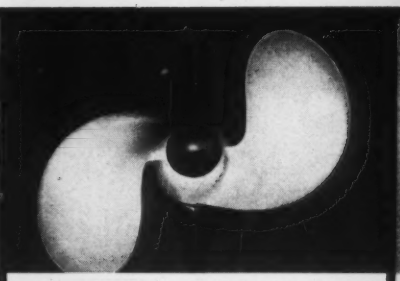
How method works

In the new process, a paste is prepared from a finely ground mixture of copper oxide and a special glass frit and blended with a standard silk screen printing vehicle. The paste is used to print the pattern on a ceramic base. The base is heat dried to remove solvents, then fired in air at 1400 F for 20 min to burn off the printing vehicle. This operation leaves a non-conducting copper oxide pattern ready to be reduced to metallic copper.

A second firing operation is con-

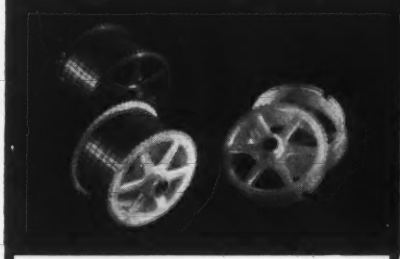


SNAP-ON FASTENERS for accordion-door covers and quiet roller wheels are made of ZYTEL, which provides resiliency and resistance to impact and abrasion. (Molded by Flambeau Plastics Corp., Baraboo, Wis., for Hough Mfg. Corp., Janesville, Wis.)



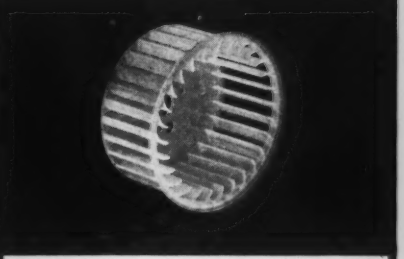
OUTBOARD-MOTOR PROPELLER, made of Du Pont ZYTEL, is tough, durable and noncorrosive even in salt water. It adjusts its pitch automatically. Use of ZYTEL makes possible considerable cost savings. (By Grish Brothers, St. John, Indiana.)

POWER-MOWER THROTTLE is molded of Du Pont ZYTEL 101 in several colors, taking advantage of this resin's toughness, wear resistance, chemical resistance and light weight. (By Western Control Corporation, Wichita, Kansas.)

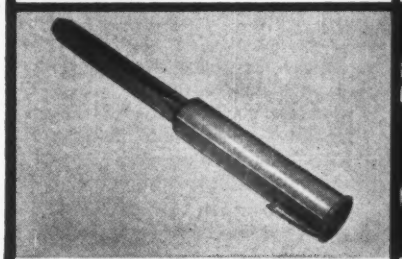


SPROCKET FOR TIME CLOCK has high strength, high fatigue-endurance limit, light weight. Injection-molded of ZYTEL, it cuts costs, simplifies assembly. (Molded by Hamilton Plastics Molding Co. for Cincinnati Time Recorder Co., both of Cincinnati, O.)

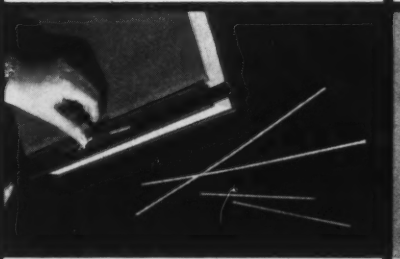
SPINNING REEL operates smoothly, is exceptionally light in weight, easy to handle and durable. Almost all parts are molded of Du Pont ZYTEL. (Molded by Plano Molding Co., Plano, Ill., for Waltco Products Incorporated, Chicago, Illinois.)



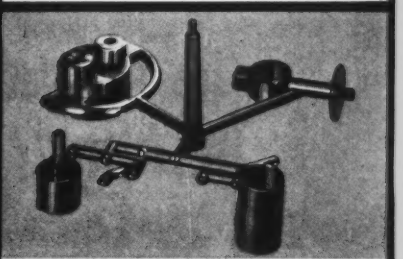
"SQUIRREL-CAGE" BLOWER is used in refrigerators. Made of Du Pont ZYTEL, this intricate, thin-walled molding has high strength, and is unaffected by the low temperatures encountered. (By Torrington Manufacturing Co., Torrington, Connecticut.)



SAND SPIKE fishing-rod holder is made of two parts of orange-colored ZYTEL. It is tough, corrosion-resistant and light in weight. (Molded by Du Bois Plastic Products, Inc., Buffalo, New York, for The Gliebe Co., Brooklyn, New York.)



POSTS for loose-leaf binders that hold business records are made of tough, flexible ZYTEL, easily threaded into holes. The posts permit greater sheet capacity, flatter opening than posts of other materials. (By Wilson Jones Co., Chicago, Illinois.)



AIR PUMP for aquarium has molded cap, bushings and cam actuator made of Du Pont ZYTEL. These parts offer high strength and abrasion resistance . . . make possible economies in production. (By Eugene Danner, Brooklyn, New York.)

Design advantages of ZYTEL® nylon resins demonstrated in wide variety of applications

Versatile ZYTEL nylon resins offer the designer a combination of properties that can be used to improve the performance and lower the cost of almost any mechanism. The high strength, abrasion resistance and low friction of ZYTEL make it an outstanding gear and bearing material. It is resistant to heat and chemicals. It can be economically injection-molded in intricate one-piece configurations, with moldings held to close tolerances. The result: reduction in inspection cost, material cost, fabrication cost.

Many molders have the experience to supply you with parts of ZYTEL nylon resin in quantity to your exact specifications. For your copy of a booklet, "Designing with ZYTEL nylon resins", write to: E. I. du Pont de Nemours & Co. (Inc.), Department W-12, Room 2507Z, Nemours Building, Wilmington 98, Del.

In Canada: Du Pont of Canada Limited, P.O. Box 660, Montreal, Quebec.

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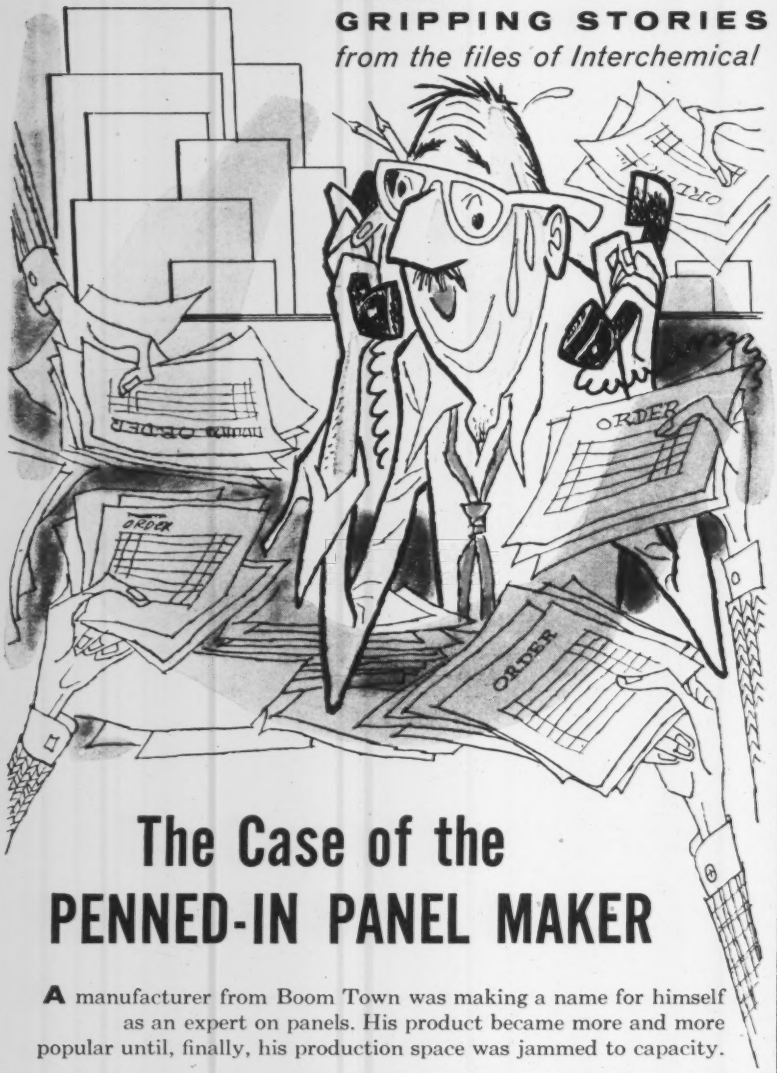
No. 6 of a Series

GRIPPING STORIES
from the files of Interchemical



The Case of the PENNED-IN PANEL MAKER

A manufacturer from Boom Town was making a name for himself as an expert on panels. His product became more and more popular until, finally, his production space was jammed to capacity.

On examining the production set-up, an Interchemical adhesives engineer quickly saw that the bottleneck was caused by the need to spray *both* the hardboard backing and plastic facing with adhesive before lamination.

"Let's see if Interchemical can come up with a one-coat adhesive that will eliminate half of your spraying requirement," he said. Interchemical could and did. And our penned-in panel maker was able to double his output without expanding his space. Interchemical's broad experience in supplying lacquers, coatings and adhesives for many industries is an important practical advantage wherever problems arise. For efficient, economical *job-formulated* adhesives — see your local Interchemical adhesive man.

Call or write today for complete information.

ANGIER ADHESIVES

INTERCHEMICAL CORPORATION
Finishes Division
120 Potter St., Cambridge 42, Mass.
Midwestern Plant: HUNTINGTON, IND.

For more information, turn to Reader Service card, circle No. 424

What's new IN MATERIALS

***Electrical circuits** are printed directly on ceramic base without the use of adhesives. Bond strengths are said to be over 2000 psi.*

ducted at 1560 F for 30 min in a controlled atmosphere containing hydrogen, nitrogen and oxygen. The hydrogen in the atmposhere reduces the copper oxides to metallic copper, and the oxygen prevents reduction of other oxides in the system and promotes good wetting of the glass frit and the ceramic. Bell says a poor bond results when oxygen is absent from the atmposhere.

Bond strength

The printed wiring bases can be dip soldered without bond failure, and without the use of corrosive fluxes. In tests of bond strength, 20-gage headed wires were attached to the pattern with a contact area of about 0.01 sq in. Bond failure did not occur until about 2000 psi tensile pull; even then the ceramic, not the bond, generally failed.

In present methods of production the bond of the copper to the ceramic or plastics base is dependent on the strength of the adhesive. Often it fails during such processing operations as soldering or assembly.

Extruded Bronze Alloy Is Wear Resistant

A manganese bronze alloy, available in extruded form, has been developed for "long wearing" applications in bushings, gears, cams, shafts and connecting rods.

The new alloy, called Ampcoloy

KNOW YOUR ALLOY STEELS . . .

This is one of a series of advertisements dealing with basic facts about alloy steels. Though much of the information is elementary, we believe it will be of interest to many in this field, including men of broad experience who may find it useful to review fundamentals from time to time.

How Heat-Treatment Affects Alloy Steels

Heat-treatment may be defined as an operation or series of operations involving the heating and cooling of steel in the solid state to develop the required properties. There are in general five different forms of heat-treatment used with alloy steel. These treatments modify the mechanical properties of the steel to suit the end use.

The five forms of treatment mentioned above, as applied to constructional alloy steels, are discussed in the following paragraphs:

(1) *Quenching and Tempering.* This form of heat-treatment usually consists of three successive operations: (a) heating the steel above the critical range, so that it approaches a uniform solid solution; (b) hardening the steel by quenching it in oil, water, brine, or salt; and (c) tempering the steel by reheating it to a point below the critical range in order to effect the proper combination of strength and ductility.

(2) *Normalizing.* A form of treatment in which the steel is heated to a predetermined temperature above the critical range, after which it is cooled to below the range in still air. The purpose of normalizing is to promote uniformity of structure and to alter mechanical properties.

(3) *Annealing.* This method consists of heating the steel to a point at or near the critical range, then cooling at a predetermined slow rate. Annealing is used to soften the steel, to improve machinability, to reduce stresses, to improve or restore ductility, and to modify other properties.

(4) *Spheroidize-Annealing.* This form of heat-treating requires prolonged heating of steel at an appropriate temperature, followed by slow cooling to produce a globular condition of the carbide. This treatment produces a structure which may be desirable for machining, cold-forming, or cold-drawing, or for the effect it will have on subsequent heat-treatment.

(5) *Stress-Relieving.* This is the process of reducing internal stresses by heating the steel to a temperature below the critical range, and holding for a time interval sufficient to equalize the temperature throughout the piece. The object of this treatment is to restore the elastic properties of the steel, or to reduce stresses that may have been induced by machining, cold-working, or welding.

Each of the five forms of heat-treatment will be the subject of a future advertisement.

Bethlehem metallurgists have had long experience in all methods of heat-treatment. They understand the possibilities and limitations of each method with respect to various alloy steels. These men will be glad to help you with any problems concerning heat-treatment. Feel free to ask for their services.

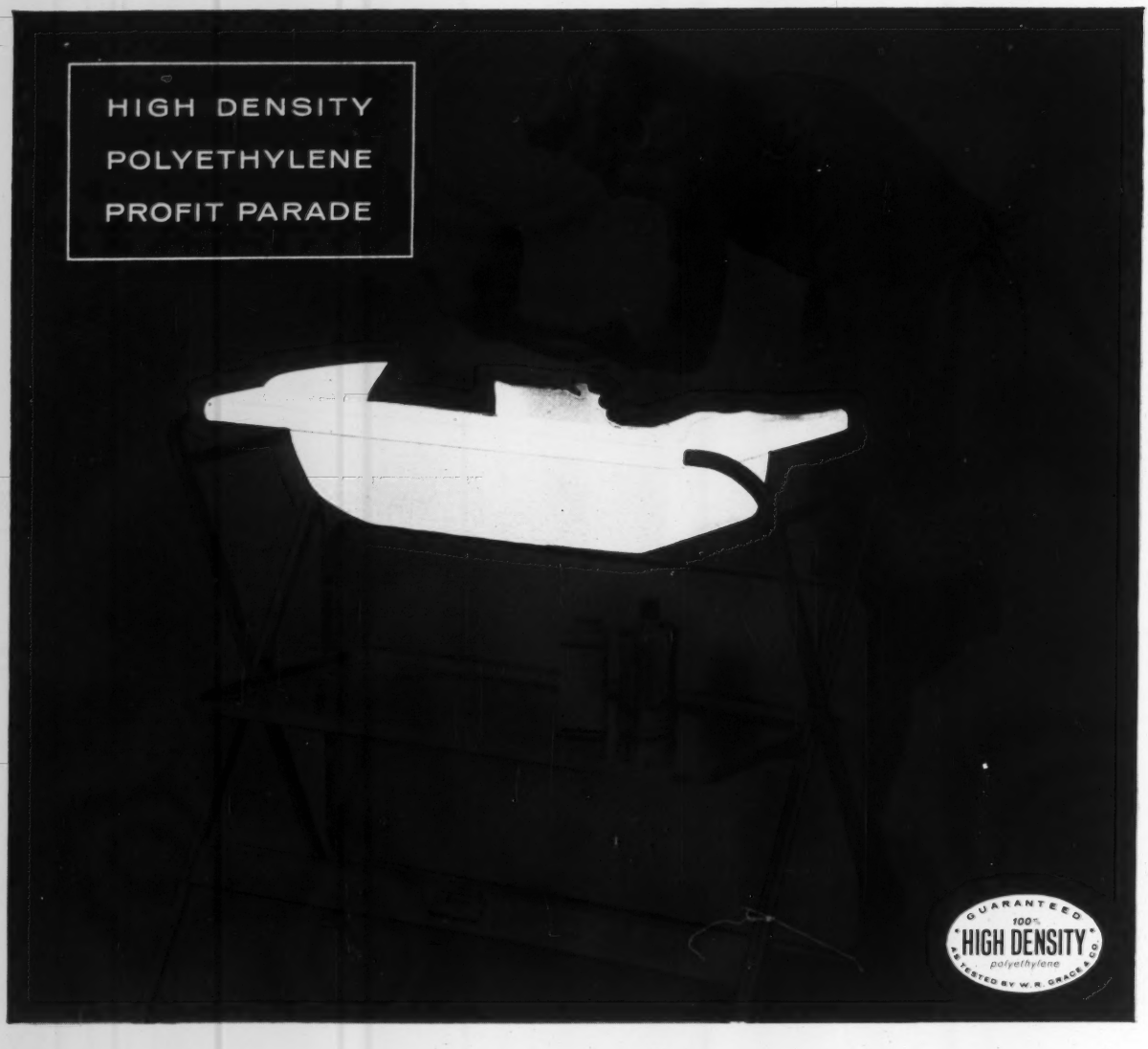
And call on Bethlehem, too, for the full range of AISI standard alloy steels, as well as special-analysis steels and all carbon grades. We can meet your needs promptly.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.
Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

For more information, turn to Reader Service card, circle No. 469



Exclusive Selling Advantages Offered in Lifetime Tub

Products in many different fields are gaining an edge over competition by utilizing the benefits of Grex high density polyethylene. The "Lifetime Tub" by Baby Bathinette Corporation is an example that really holds water.

This well-known manufacturer chose Grex to make a tub that would outlast competitive models since this is a tough plastic that is virtually indestructible. They used its molding characteristics to obtain a soft, pleasant, easy-to-clean texture. They took advantage of its strength and rigidity to make the tub light in weight for greater ease of carrying.

This new Grace plastic offers a unique combination of properties to help you create unique selling advantages. It takes a beating without chipping, cracking or breaking. It can be molded in any color and decorated. It resists the elements and most corrosive chemicals. And it is the only thermoplastic that takes boiling or freezing without losing its shape or strength.

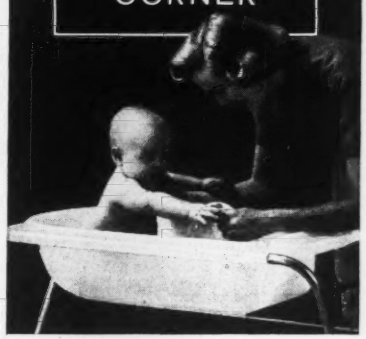
If you need an idea of how to gain an edge over competition by using high density polyethylene be sure to call in the experts. Grace has the production facilities, technical service and experience to help put your product in the Grex profit parade. We're easy to do business with.

Grex is the trademark for W. R. Grace & Co.'s Polyolefins.

W.R. GRACE & CO.
POLYMER CHEMICALS DIVISION CLIFTON, NEW JERSEY

For more information, turn to Reader Service card, circle No. 436

GRACE TECHNICAL CORNER



Grex answers design and molding problems on extra-large piece.

Don't let size limit your thinking when designing or molding with Grex high density polyethylene. The "Lifetime Tub" shown here is 30½" x 6½" x 19"—one of the largest pieces so far injection molded with this Grace plastic. Some of the technical thinking that went into this job may give you an idea of how to get the most from Grex.

Cost a design factor. Production of a piece as large as this tub invariably presents a cost problem. Taking advantage of the way Grex performs in thin wall sections, the designers were able to keep the amount of resin per tub to a minimum and permit economical cycle times. Use of thin walls, however, called for a design that would not only take care of the weight of baby and water but also provide for satisfactory suspension of the tub in its metal frame. Reverse curves solved both problems and minimized use of ribs and fillets to avoid heavy sections, sinks and depressions.

Mold surface. Depending on mold surface, Grex takes any finish ranging from high gloss to matte. In this case, it provided a smooth, pleasant texture—essential to protect baby and make cleaning easy—through the use of a highly polished chrome-plated mold.

Molding technique. Production of the tub involved a 3-pound shot of Grex, a large mold cavity and thin wall sections. Under these conditions, multigating was chosen over normal gating. With four gates the cavity was filled faster and strain reduced.

What are your problems? If you have a job in mind for high density polyethylene count on Grace for help. Now's the time to call, wire or write:

Technical Service Department,
Polymer Chemicals Division,
W. R. Grace & Co., Clifton, N. J.

What's new IN MATERIALS

COMPOSITION OF AMPCOLOY 666 (%)

Manganese	2.20-2.80
Copper	57.0-60.0
Aluminum	1.45-1.75
Silicon	0.55-0.80
Lead	0.40 max
Others	0.50 max
Zinc	Balance

PROPERTIES OF AMPCOLOY 666

Tensile Strength, psi	80-88,000
Elongation (in 2 in.), %	12-18
Hardness (Rockwell)	B87-91

666, is marketed by Ampco Metal, Inc., 1745 S. 38th St., Milwaukee 46, Wis. It is said to have good corrosion resistance and good machinability. It is supplied from stock in a number of diameters in standard mill lengths or cut to customers' specifications.

Ceramic-Coated Wire Used to Wind Motors

A flexible, ceramic-coated copper wire has been used successfully to wind specialty transformers and fractional horsepower motors. The wire was coated with a porcelain enamel made of frit, bentonite, sodium silicofluoride and water.

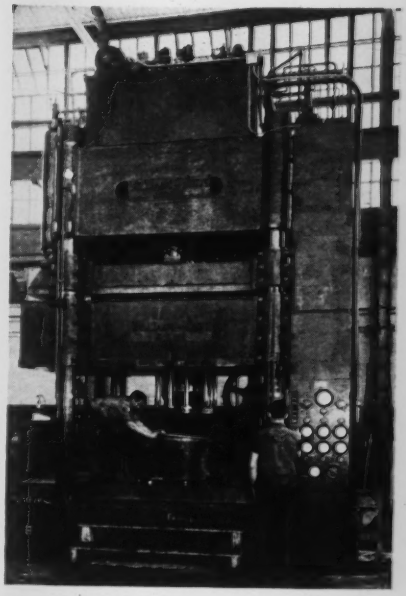
Tests show that the flexibility of the ceramic-coated wire is such that there is no visible failure after the wire has been wound to a 1-in. dia mandrel at room temperature. Heating the coated wire to 1650 F increases its flexibility.

Tests also show that the coated wire is resistant to such organic solvents as carbon tetrachloride, benzene, acetone and Freon 22.

The ceramic-coated wire, still in the development stage, came out of work done by B. W. King, G. D. Kelly and W. H. Duckworth of Battelle Memorial Institute, 505 King Ave., Columbus, Ohio, and J. H. Terry of General Electric Co., Ft. Wayne Laboratory, 1635 Broadway, Ft. Wayne, Ind.

Coating is applied by continuous process

The researchers, who described their work in the May '59 issue of the *American Ceramic Bulletin* (Vol.



TOP LEVEL
EQUIPMENT TO DRAW, WELD and FABRICATE
YOUR COMPONENTS OR END PRODUCTS...

Exclusively in Stainless Steel

Giant presses for extremely deep and complex draws in stainless. . . . Automatic heli-arc and manual weldments of superb strength and quality. . . . Extensive machining and polishing facilities. . . . And a large plant so versatile that we welcome one or a million pieces.

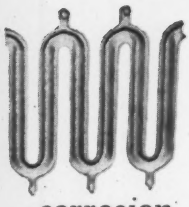
But more than that A-P-C engineers offer a KNOW-HOW in stainless steel that is virtually unique . . . gained over wide experiences in stainless steel since 1929.

For quotations, counsel or engineering call in the man from A-P-C.

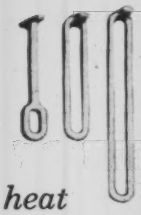
ALLOY PRODUCTS CORP.
1070 Perkins Ave., Waukesha, Wis.

2037
For more information, circle No. 476

SHELL MOLDED PARTS



corrosion resistant



heat resistant

abrasion resistant

DURASHEL

- *accuracy*
- *superior finish*
- *cut machining*
- *low cost*

We are equipped to help you pick the right alloy for planned service conditions...We are equipped to help you design your part to take advantage of the possibilities of shell molding...We are equipped to manufacture high alloy, shell molded parts to your specifications in quantity and on time!

We suggest you check on shell molding for your high alloy casting requirements. Write us today for additional information.

The DURALOY Company

OFFICE AND PLANT: Scottdale, Pa.
EASTERN OFFICE: 12 East 41st Street, New York 17, N. Y.
ATLANTA OFFICE: 76—4th Street, N.W.
CHICAGO OFFICE: 332 South Michigan Avenue
DETROIT OFFICE: 23906 Woodward Avenue, Pleasant Ridge, Mich.

For more information, turn to Reader Service card, circle No. 389

38, No. 5), say a pilot plant has been designed for continuous application of the coating to the wire. Wire is first pulled through an enamel slip, then through a firing chamber, and finally onto a coil winding mechanism. Operating speeds vary from 18 fpm for fine wire to 10 fpm for heavy wire. Nitrogen gas is used for the furnace atmosphere, and the coating is fired at a peak temperature of 1650 F.

Pure Tungsten Shapes Made by New Process

High purity tungsten metal (99.99% pure) is being formed into tubing and other simple shapes by a technique developed at the Bureau of Mines Laboratories in Rolla, Mo.

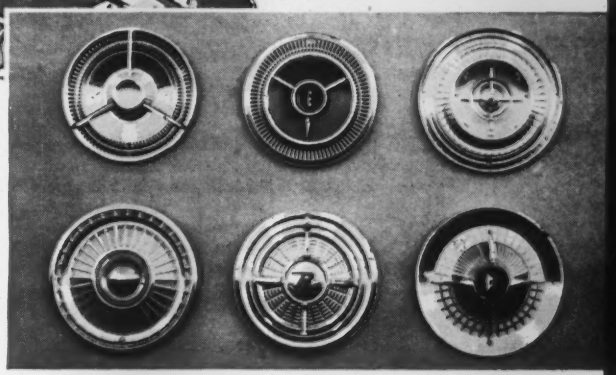
With the new technique, still in the development stage, high purity metal is extracted from a mixture of tungsten hexafluoride and hydrogen gases by pumping the mixture through a copper tube heated to about 1100 F. Tungsten drops out of the gas stream as pure metal; impurities remain in the stream and pass out of the tube. The pure tungsten metal builds up on the walls of the tube. When this "inner tube" of tungsten reaches a desired thickness, the process is halted and the copper tube is stripped off, leaving the high purity tungsten formed into a useful shape.

Rayon Fibers Used for Precision Filtration

Two new filter media—a nonwoven rayon fiber, and a chemically crimped rayon staple in a specially designed cartridge—are designed for precision filtration of liquids, solids and gases.

1. Nonwoven rayon

The nonwoven rayon filter material, trademarked Hovolite, was developed by Hollingsworth & Vose Co., East Walpole, Mass. The material is presently being used to filter radioactive dust in atomic energy installations. The nonwoven filter material is also expected to be used for the removal of all types



Can you name the cars represented by these stainless steel wheel covers? A postcard request will bring you the answers.

Brightness is Not Enough

Wheel covers must be more than just bright. They must have strength, spring temper, durability and low unit cost in volume production.

Other materials may claim some of these characteristics, but only stainless steel actually possesses all of them — and has a performance record to prove it.

It is easy to **make cheaper wheel covers.** Just forget that customer complaints, lost goodwill and the inevitable replacement of parts eventually show up on the balance sheet.

In wheel covers there is no substitute for stainless steel's lasting brightness, strength and durability.

J&L STAINLESS
SHEET • STRIP • BAR • WIRE

Plants and Service Centers:
Los Angeles • Kenilworth (N. J.) • Youngstown • Louisville (Ohio) • Indianapolis • Detroit

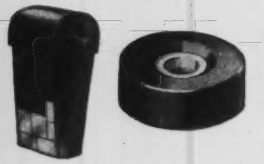
For more information, turn to Reader Service card, circle No. 446

Jones & Laughlin Steel Corporation • **STAINLESS and STRIP DIVISION** • **Box 4606, Detroit 34**

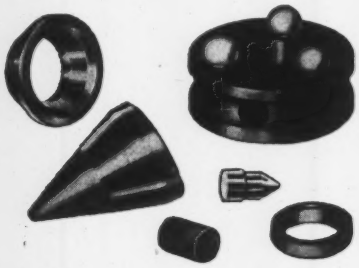
Reliability is a most important characteristic of KENNAMETAL*

Exceptional characteristics of Kennametal have solved varied problems in many fields. But one of the most important contributions made by Kennametal to any project is *reliable performance* . . . delivering the expected service and life under given conditions. That's why Kennametal is used more and more where it is found or feared that other materials just aren't good enough.

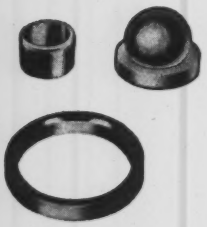
Will these *dependable* characteristics of KENNAMETAL hard carbide alloys help solve some of your problems?



DEPENDABLE resistance to abrasion . . . for such component parts as spray nozzles, orifices, seal rings, bushings, pulverizing hammers, drawing and compacting dies.



DEPENDABLE resistance to corrosion, cavitation and wear . . . vital to valving in oil well operations, hydraulic systems, parts for chemical processing equipment exposed to strong mineral acids, red fuming nitric acid and similar highly corrosive agents.



DEPENDABLE strength at high temperatures . . . needed for gas turbine components, sensing elements for jet stream thermostatic controls, parts to handle or process glass in semi-plastic state and flame burner tips. For such applications, Kentanium,* a series of hard titanium carbide alloys, retains high strength for continuous operation at temperatures up to 2200°F and provides high stiffness/weight ratio.

DEPENDABLE resistance to deformation . . . as required in cylinder liners to prevent leakage around pistons when compressing gases at pressures as high as 35,000 psi, or in components for high pressure valves. (Kennametal has a YME up to 94 million psi, 3 times that of hardest steel.)

For more information, send for: Booklet B-111A, "Characteristics of Kennametal," Booklet B-222, "Designing with Kennametal," Booklet B-444A, "Kentanium." Write to Dept. MDE, KENNAMETAL INC., Latrobe, Pa.

*Trademark

97280

INDUSTRY AND KENNAMETAL ...Partners in Progress

For more information, turn to Reader Service card, circle No. 514

What's new IN MATERIALS

Filter cartridge, *here being inserted in a canister, is presently used to filter paint, varnishes and lacquers.*

of dusts, mists, fumes, smokes and pollens from air and gases; for the removal of solids from liquids; and for the separation of immiscible liquids. The developer says Hovolite can be heat sealed to itself, and can be easily laminated and heat formed. It is available in thicknesses ranging from 0.1 to 1 in., in rolls, sheets, die-cut pieces and fabricated parts.

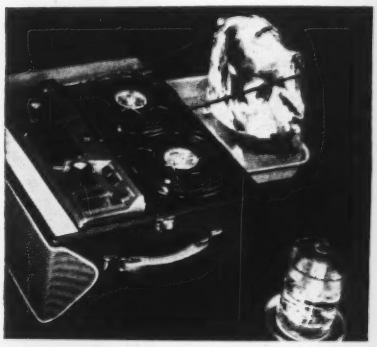
2. Chemically crimped rayon

The chemically crimped rayon is used in combination with a specially designed cartridge. The filter media, called Feutron, was developed by American Felt Co., Glenville, Conn. The filter cartridge consists of a perforated aluminum core with rayon fiber disks locked in place around the core with retaining rings. The edges of the disks are scalloped to give maximum filtering action. American Felt Co. says its cartridges are "depthwise" filters rather than "surface" filters; i.e., filtration is parallel to the fiber orientation, thus giving a greater depth of filtration than when flow is perpendicular to fiber orientation. Although the filter cartridge has found its first commercial use in the paint industry, company officials say it can also be used in other filtration applications where exacting clarity is required.

(more What's New on p 166)

MYLAR® is moisture-resistant . . . has operational temperature range –60° to 150° C

Can the unique combination of properties found in "Mylar" help solve your design problems?



Temperature-humidity resistance assures reliable tape performance. Test provides dramatic proof that magnetic recording tape made with "Mylar" is unaffected by changes in temperature and humidity.

"Mylar"* polyester film is a tough, flexible engineering material. In addition to moisture and temperature resistance (-60° to 150°C.), "Mylar" is unaffected by most chemicals . . . has an average tensile strength of 20,000 psi and a dielectric strength of 4,000 volts per mil for 1 mil film.

On an area basis, tough, thin "Mylar" often *costs less* than heavier, conventional materials. "Mylar" can be embossed, laminated and metalized, punched or coated. The film won't embrittle with age. "Mylar" is available in roll or sheet form . . . in a wide range of gauges.

Find out how the *combination of properties* in "Mylar" can help you solve knotty design problems, improve product performance or cut costs. Write for our booklet containing detailed information on properties and applications. E. I. du Pont de Nemours & Co. (Inc.), Film Dept., Room MM-12, Wilmington 98, Del.

*"*Mylar*" *is Du Pont's registered trademark for its brand of polyester film.*

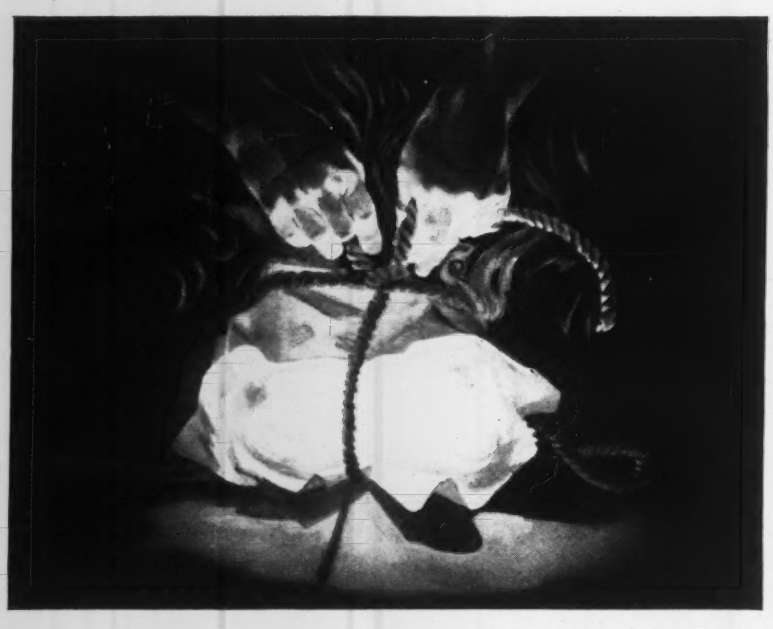
DU PONT
REG. U.S. PAT. OFF.
BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

DU PONT MYLAR® POLYESTER FILM

For more information, turn to Reader Service card, circle No. 408

How to wrap up 2000°F!

Searing heats up to 2000° F can now be contained in "packages" of tough, lightweight FIBERFRAX® ceramic fiber insulation. Processed in a wide variety of forms, it offers the ultimate in versatility for high temperature insulation. For further details, see below.



Ceramic fiber in many forms extends insulation heat limits

FIBERFRAX® ceramic fiber provides insulations which can be used above the temperature limits of mineral wools, glass fiber and asbestos and alumina-silica compositions. It is chemically inert and has low thermal conductivity.

- **BULK FIBER** makes a resilient insulating packing for cracks and expansion joints, furnace walls, annealing cars, induction furnaces, etc.

TEXTILES include *yarn* for high temperature thermocouple and electrical wire insulation, *rope* for gasketing in molten metal casting and other high temperature processes, *cloth* for flame curtains and temperature resisting membranes.

- **PAPER** offers a thin fibrous mat for lining oil-fired combustion chambers, a resilient pressure distribution and thermo-balance sheet for stainless steel honeycomb brazing, as well as a gasketing material.
- **BLOCK** features low thermal conductivity and heat capacity, immunity to thermal shock and inertness in hydrogen and other atmospheres.
- **FELTS** provide a convenient insulating wrap for high temperature pipes, flanges and furnace parts.
- **COATING CEMENT** air-sets to an insoluble, dense, heat resisting surface, bonds well to many porous and non-porous materials.

To learn more about this interesting material . . .

send for your FREE COPY of
ADVANCED MATERIALS TECHNOLOGY

A new quarterly publication dealing with materials for severe service applications, published by Carborundum. For your FREE subscription, write to Carborundum, Research & Development Division, Dept. MDE-129, Niagara Falls, N. Y.

Where conventional materials fail... call on

CARBORUNDUM
Registered Trade Mark

For more information, turn to Reader Service card, circle No. 390

What's new IN MATERIALS

Gold Chips Brighten Consumer Products

Gold, silver and other colored metallic and nonmetallic chips are presently available for adding a decorative touch to a wide variety of consumer products.

1. Metallic chips

Metalflake is the trade name for tiny chips of precision-cut colored metallic foil. The chips are made by Dobeckmun Co., Div. of Dow Chemical Co., 3301 Monroe Ave., Cleveland 13, Ohio. The producer says the chips can be laminated or molded into such products as vinyl flooring, acoustical ceiling and wall panels, wallpaper, gift wrapping paper and other products. The metallic chips are offered in a variety of shapes and sizes ranging from fine grains to large squares, geometric shapes, stars and cut threads.

2. Nonmetallic chips

Gold nonmetallic chips derived from the mineral vermiculite are now commercially available from Engineered Materials, P. O. Box 363, New York 8. The chips are supplied in particle sizes ranging from –10 to 200 mesh. According to the producer, the material can be flocked or dusted onto any surface adhesive, and can be mixed or ball-milled into most plastics, paint and paper formulations. The chips are said to withstand temperatures up to 1000 F, and are fireproof, rotproof and chemically inert.

Sand Castings Made of Modified A-356 Alloy

Rolle Mfg. Co., Lansdale, Pa. is producing aluminum sand and permanent mold castings made of a modified A-356 alloy. The new alloy is made by adding 0.03 to 0.25%

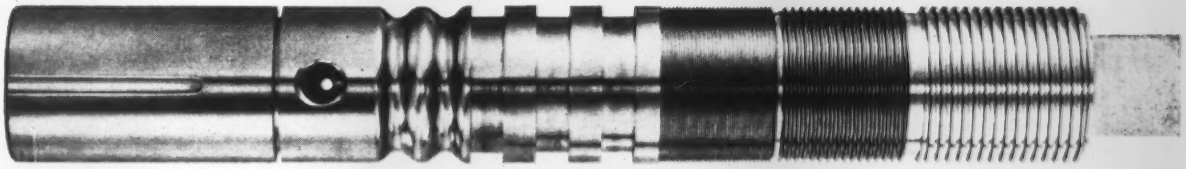
PROPERTIES OF A-356 AND MA-356*

Alloy →	A-356	MA-356
Tensile Strength, psi	40,000	40-50,000
Yield Strength, psi	30,000	30-40,000
Elongation, %	3	2-5

*Tests performed on specimens in the T-6 condition.

THEY LAUGHED WHEN WE SAT DOWN TO PLATE...

they didn't know about KANIGEN®



This shaft was turned. It was key-slotted, drilled, tapped and shouldered. It was threaded, milled, grooved and chamfered. It was step-bored, with three inside diameters. Who could plate a piece like this all over—inside and out—and expect a uniform coating?

Well, anyone who used KANIGEN® could expect it—and get it. In fact, we made this piece especially to prove it.

The KANIGEN® process for chemical nickel alloy plating produces a uniform thickness of coating, regardless of the contours of a part. This uniformity permits full machining operations prior to coating, with no subsequent cleanup.

KANIGEN® offers corrosion resistance equal or superior to that provided by wrought or electrolytic nickel.

For complete technical details write or call your nearest General American office. Ask for Kanigen Bulletin No. 258. You'll find that with plating as in so many other industrial areas, *it pays to plan with General American.*

Kanigen Division

GENERAL AMERICAN TRANSPORTATION CORPORATION

135 South LaSalle Street • Chicago 3, Illinois

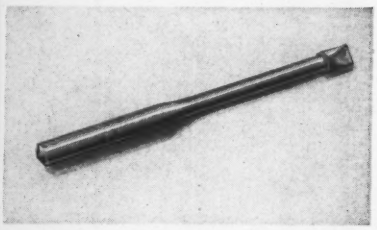
Offices in principal cities

KANIGEN GENERAL AMERICAN TRADE MARK

For more information, turn to Reader Service card, circle No. 461

NEWS
from Torrington on
SMALL PRECISION METAL PARTS

Ordinarily, one would not think of "custom manufacture" and "mass production" in the same breath. Except at Torrington's Specialties Division, where the production of tremendous varieties and quantities of small metal parts of exceptional precision and uniformity is a day-to-day occurrence.



A good example is the valve stem we make for a leading pump manufacturer. Operations include turning, threading, slotting and tempering. Nothing unusual about that, except that Torrington can do it to such precision that the specified finish of 4 to 6 micro-inches is achieved without grinding. This saves our time—and our customer's money, yet every part is produced to perfection.

Another interesting case is an insulated contact pin. It is driven into wood to check moisture content by electrical conductivity. The reduced center section is insulated. The shank must be accurate to ±.0005", and the diameter of the tapered neck to +.005", −.000". Torrington's engineers devised a way to back-swage the neck to required taper and trim square between head and reduced section *automatically*.

The manufacture of such parts as these, in the tremendous quantities required of us every day, demands highly specialized engineering skills. To serve you most efficiently, our Specialties Division maintains a separate engineering department. Staffed with engineers who have wide experience in precision metalworking, the department can help you with any engineering problems that might arise

in the manufacture of your special metal parts. For prompt service, just circle our number on the reply card, call our area salesman or write direct to:

The Torrington Company, Specialties Division, 777 Field Street, Torrington, Conn.

TORRINGTON SPECIAL METAL PARTS

Makers of Torrington Needle Bearings

For more information, turn to Reader Service card, circle No. 386

COMPOSITION OF A-356 and MA-356 (%)

Alloy ➡	A-356	MA-356
Copper	0.20	0.20
Silicon	6.5-7.5	6.5-7.5
Iron	0.20	0.20
Manganese	0.10	0.10
Zinc	0.10	0.10
Magnesium	0.20-0.40	0.20-0.75
Titanium	0.20	0.20
Beryllium	—	0.03-0.25
Others	0.15	0.15
Aluminum	Balance	Balance

beryllium to A-356 and by increasing the magnesium content of A-356 from a maximum of 0.40% to 0.75%. The resulting material, called MA-356, is said to be highly responsive to heat treatment, and is said to exceed the physical requirements set forth in specification MIL-C-21180A.

Filled Teflon 100X Is Rigid, Wear Resistant

Incorporating fillers in Teflon 100X FEP fluorocarbon resin is a practical method for improving certain important mechanical properties while retaining many of the outstanding chemical and electrical qualities of the resin.

Work done at the Polychemicals Dept. of E. I. du Pont de Nemours & Co., Inc., Wilmington, Del. shows that although the changes in properties were heavily dependent on the type and concentration of filler used, most of the additives yielded real improvements in stiffness and resistance to wear.

Fillers evaluated ranged from fibrous materials such as fiberglass and TFE fluorocarbon fibers to powders such as silica, graphite and talc.

Fiberglass offers best combination of properties

Teflon 100X containing 10 or 20% fiberglass offered the best combination of properties of the filled compositions evaluated. Compositions containing 10% fiberglass had lower mold shrinkage and approximately a thousandfold gain in the crack resistance associated with such improvement. Bearing wear was reduced by a factor of about 3000 by

HANDY & HARMAN SILVER BRAZING
Permits Manufacturer to Guarantee Underwater Air Regulator For Life

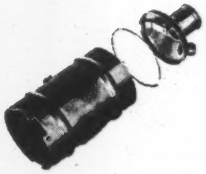
Perhaps the most vital component of a skin diver's equipment, this Viking Air Regulator, manufactured by Christensen Tool & Engineering Company, Norwalk, Connecticut, is structurally guaranteed for life. It must, under all conditions, be absolutely leaktight. The manufacturer's guarantee is a relatively recent achievement—through the high-strength help of silver alloy brazing with Handy & Harman EASY-FLO 45 and HANDY FLUX.

Over and above the unreserved dependability of brazed joints, the brazing method itself has saved the company considerable time, money and material in the production of the Viking Air Regulator. Brazing's simplicity is interestingly illustrated in this case by this company's requirement that assemblers and testers of the Viking must be skin divers themselves.

Almost invariably, silver brazing effects economies and brings advantages to whatever part, product or assembly it is applied. True, air regulators are few and far between, but the point is that they are *metal products, made of a number of different metal components.*

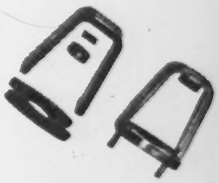
And that's the phrase that covers brazing's great adaptability. To give you a good idea of how you can put brazing to work, we'd like to send you Bulletin 20—it covers the basics of brazing and it may very easily solve your metal-joining problems. Handy & Harman, 82 Fulton Street, New York 38, N. Y.

Here, in "serial" form is how the guarantee is "brazed" into the Viking:



1. TANK HOUSING—Initially, this component was mechanically joined and made "airtight" by means of sealants. Now, brazing eliminates 8 holes, 4 tapping operations, 4 screws and 3 assembly operations.

5. Shown here are the finished Viking components before and after assembling. —Brazing by Specialty Brazing Laboratories, Riverside, Connecticut.



3. YOKE—This is assembled from stampings instead of castings, which were previously used. With brazing, no secondary finishing operations are required. Further, the part is stronger and lighter, and savings on material and labor on this component alone add up to 28%.

Your No. 1 Source of Supply and Authority on Brazing Alloys

2. FORK ASSEMBLY—There are five separate brazed joints, done with hand torch and hand-fed wire. Brazing eliminates one tapped hole, a lock washer and a spacer, plus the fact that positive alignment is now guaranteed.

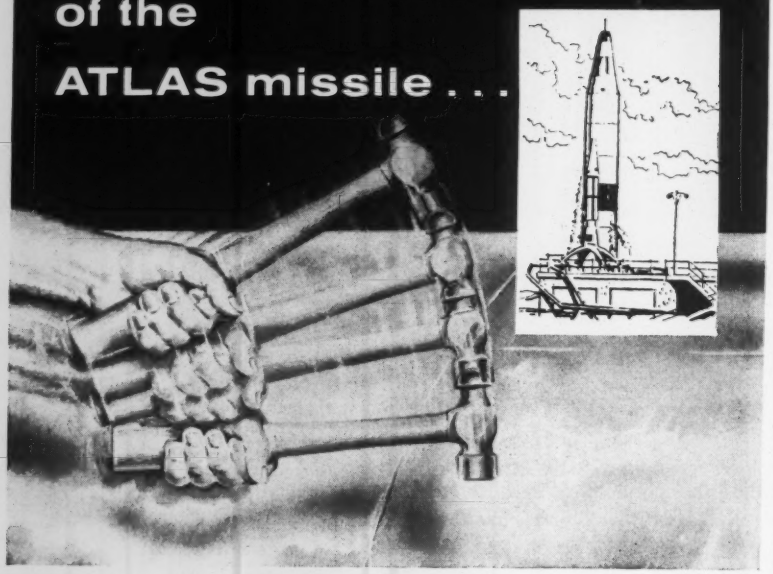
HANDY & HARMAN
General Offices: 82 Fulton St., New York 38, N. Y.
DISTRIBUTORS IN PRINCIPAL CITIES

4. PISTON—This is the most important single element of the Viking. It regulates flow of oxygen from cylinder to mouthpiece; from 300 lbs. pressure to normal breathing. Without brazing, this part could not be made.

COMING IN NOVEMBER! *New Handy & Harman Brazing Correspondence Course. Simple self-study data on all phases of brazing. Send for details to Dept. BC.*

For more information, turn to Reader Service card, circle No. 502

How an ordinary hammer proved the case of the ATLAS missile . . .



The body of the missile, essentially one big fuel tank, is similar in principle to an inflated football. Convair-Astronautics broke new ground in missile design by developing a super-strong structure with a comparatively thin stainless steel skin to keep weight to a minimum. This stainless steel skin is so thin that the interior has to be pressurized to preserve the shape of the body as propellants are consumed in flight, or when the missile is being transported on the ground.

Some critics, however, thought the body was too fragile—"You could dent it with a hammer." So, recently, when the Scientific Advisory Board, engaged in a re-evaluation of all missile programs, arrived at Convair-Astronautics to take a reading on the ATLAS, they found that Convair had thoughtfully placed a number of hammers within easy reach of a finished missile. "Go ahead, bash it," invited Convair. The SAB members swung lustily. *Not a dent was registered*, for, although the walls are thin, the stainless has a minimum tensile strength of 200,000 psi.

This stainless steel skin material, supplied by Washington Steel, required extremely close control of mechanical properties and gauge tolerance which are regularly produced through Washington Steel's long experience with precision rolling equipment.

Stainless Steel—the Space Age Metal

Washington Steel Corporation
12-F Woodland Avenue
Washington, Pa.

For more information, turn to Reader Service card, circle No. 421

What's new IN MATERIALS

PROPERTIES OF FILLED AND UNFILLED TEFLON 100X

	Unfilled	Filled[a]
MECHANICAL PROPERTIES		
Ten Str, psi	3250	2310
Elongation, %	320	220
Flexural Mod, %[b]	100	150
Tensile Mod, %[b]	100	160
Flex Life, %[b]	100	16
Impact Str, %[b]	100	72
Res to Cracking, %[b]	100	>100,000
ELECTRICAL PROPERTIES		
Dielec Const	2.08	2.26
Dissip Factor	0.0002	0.0005
Dielec Str, v/mil	1360	1225
Surface Res	$>10^{16}$	$>10^{16}$
Volume Res	$>10^{17}$	4.5×10^{15}

[a]Reinforced with 10% fiberglass.
[b]Percent relative to unmodified Teflon 100X.

the presence of 10% fiberglass. Incorporating 20% fiberglass filler improved stiffness and resistance to deformation by a factor of about 2. Fiberglass also gave substantial reduction in mold shrinkage, thereby reducing the cracking tendency of the resin when fabricated in complex shapes over metal parts.

Fabrication

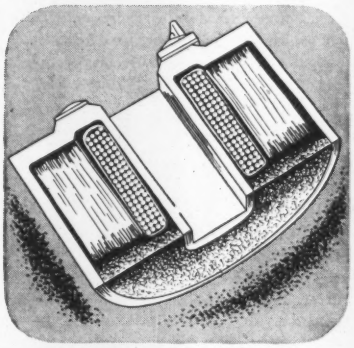
Filled compositions of Teflon 100X may be fabricated by both injection and compression molding under conditions closely approximating those used for unfilled resin. Extrusion of filled resin in the form of wire coating or tubing does not appear practical because of the unusually low extrusion rates necessary for producing acceptable products.

(For more information on FEP fluorocarbon resin, see M/DE, Apr '58, p 171 and this issue, p 131.)

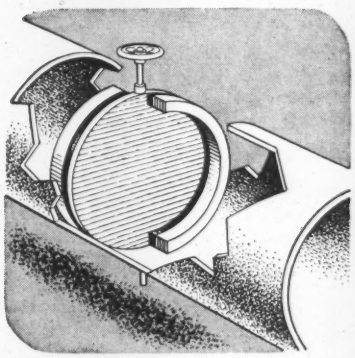
Lead-Vinyl Material Stops Vibration, Sound

Coustifab is the name given to a new high density, low mass, sound and vibration dampening material developed by Cordo Chemical Corp., 34 Smith St., Norwalk, Conn. The material is a flexible vinyl plastic sheet impregnated with metallic lead powder and backed with woven fiberglass cloth, cotton duck or other

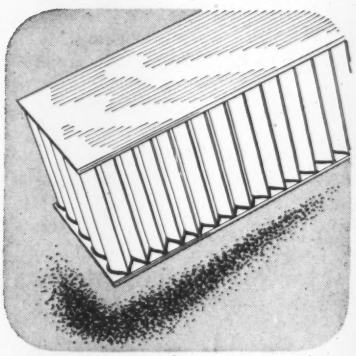
Tailored R/M *Ray-BOND*® Adhesives speed and simplify your production, cut your costs



Sealing hundreds of wires with an R/M encapsulating compound.



Bonding rubber seals to rotating water gate valves.



Resin-treated paper bonded to metal saves weight in this honeycomb.

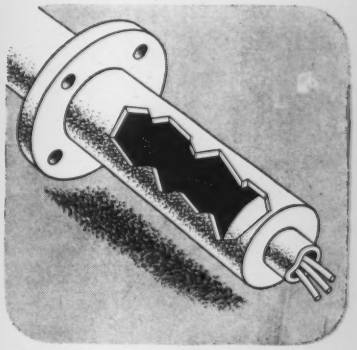
For these and 1001 other applications, new R/M Ray-BOND adhesives can be tailored to your needs

Adhesive bonding offers you many advantages. Because it eliminates rivets and other fasteners, your production costs are reduced and many assemblies otherwise difficult or impossible can be done with ease. With Ray-BOND adhesives, you can join dissimilar materials. Where unusually high or low temperatures constitute a problem, adhesive bonding frequently furnishes the ideal solution. It provides better heat conductivity, seals gaps and voids in metal products, and increases the life of friction members.

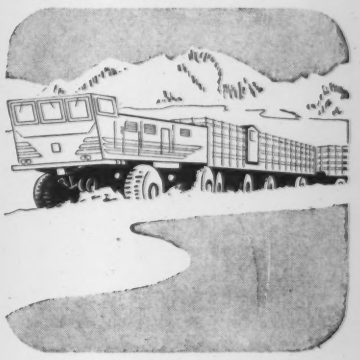
Ray-BOND Adhesives have proved themselves in a great variety of applications, and on products ranging from sewer pipes to snow trains, from ribbons to tool tips, from submarines to aircraft. They have been chosen because they resist temperatures as low as –80°F or as high as 700°F.

Raybestos-Manhattan offers you the benefit of more than 20 years of experience and pioneering in the production of bonded assemblies and the manufacture of adhesives and coatings. Feel free to call on R/M engineers for their help.

Write now for your free copy of R/M Bulletin 700, containing engineering information on Ray-BOND adhesives, protective coatings and sealers.



Bonding vinyl jacket and steel gland in cable —protecting against moisture and corrosion.



Bonding brake linings for sub-zero operation in snow train.

Making weatherproof bond between sealer strip and car door.

R/M

RAYBESTOS-MANHATTAN, INC.

ADHESIVES DEPARTMENT: Bridgeport, Conn.

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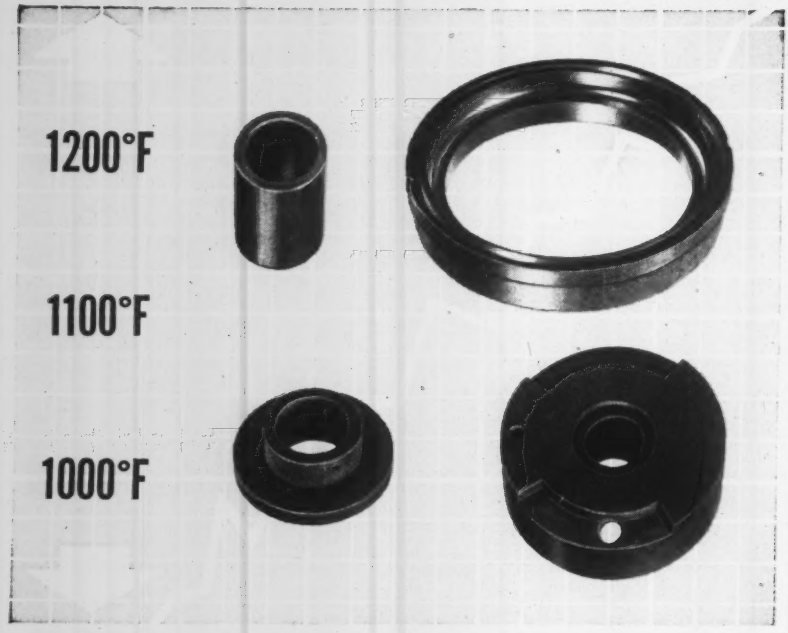
RAYBESTOS-MANHATTAN, INC., Industrial Adhesives • Brake Linings • Brake Blocks • Clutch Facings • Industrial Rubber • Engineered Plastics • Sintered Metal Products Rubber Covered Equipment • Asbestos Textiles • Laundry Pads and Covers • Packings • Abrasive and Diamond Wheels • Bowling Balls

For more information, turn to Reader Service card, circle No. 381



A NOTABLE NEW HIGH-TEMPERATURE GRAPHITE

for mechanical uses

When mechanical applications call for a material having low friction and low wear rates at temperatures where ordinary graphite and even many metals fail, Stackpole Grade 469 high-temperature graphite may well be the answer. Typical applications include extensive use as main bearing oil seals on turboprop engines and as bearing inserts in turbine blade pitch adjusting mechanisms.

A special treatment that inhibits oxidation assures maximum performance between 1000° and 1200° F. and will not "bleed out." The material is also good at lower temperatures.

Grade 469 is self-lubricating, will not seize or fuse and is unaffected by most chemicals and gases. Transverse strength is better than average. It is supplied in blanks or finished pieces or as bearings press-fitted into stainless steel housings.

Hundreds of other low-cost Stackpole carbon and graphite materials are likewise available. Send details of your application for suitable grade recommendation.

STACKPOLE CARBON CO., St. Marys, Pa.

STACKPOLE

BRUSHES for all rotating electrical equipment • COMPOSITION ELECTRICAL CONTACTS • BEARINGS • SEAL RINGS • VOLTAGE REGULATOR DISCS MOLDS & DIES • FRICTION SEGMENTS • CORROSION CONTROL RODS HEATING ELEMENTS • CHEMICAL ANODES • BRAZING BOATS • WELDING CARBONS . . . and many other carbon, graphite and metal powder products.

For more information, turn to Reader Service card, circle No. 406

fabric. The material can be supplied with a pressure-sensitive adhesive backing for application to metal and other surfaces.

The new product is expected to be used in such applications as linings for machinery housings, noise suppressor covers for pumps and compressors, ceiling and cabin wall coverings for aircraft and helicopters, and sound and vibration dampening materials in business machines, card punchers, dictating equipment, wind tunnels, computers and wall panels.

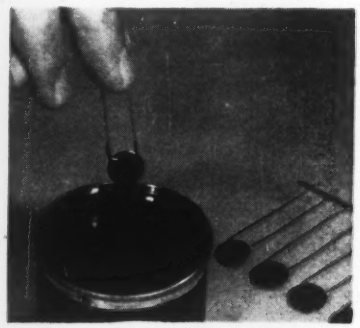
Coustifab is manufactured in several different weights and can be obtained in rolls from 1 to 38 in. wide.

Epoxy Compounds for Potting, Encapsulating

Three new epoxy compounds have recently been introduced for potting, encapsulating, molding and wire coating.

Two of the compounds are available from Houghton Laboratories Inc., Olean, N. Y. One is called Hysol 10-55 and is designed for protecting electric motor stator windings against moisture, dirt, abrasives, chemicals and other contaminants. The epoxy compound is a two-part system that can be applied with a spatula. The consistency of the compound prevents it from dripping.

Houghton's other compound, Hysol 86-10, is designed for encapsulating small electrical components by dipping. Since the compound is thixo-



***Dipping** small electrical parts into new epoxy encapsulating compound.*

Textured vinyl finishes now produced with sprayed coatings

To get a textured vinyl finish, designers are no longer restricted to laminated types. Two recent M&T developments in *sprayed* vinyl coatings make such appealing finishes especially easy to adopt. Actually, they *widen* the variety of patterns practical for metal panels, cases, housings and other parts.

TWO WAYS TO FINISH

Texture is produced chemically with *Unichrome Coating 6400*. Sprayed on smooth metal sheets and shapes, this coating gives a handsomely textured finish with warmth and leather-like appearance.

Unichrome Coating 6440 was developed for use on mill-patterned steel or aluminum, now becoming available in an increasing number of extremely attractive patterns. This coating does not alter the profile of the pattern. Whether applied thick or thin, it will faithfully mirror even the most delicate design rolled into the metal.

EXCEPTIONAL DURABILITY

Both of these sprayed vinyl coatings prove up to ten times more wear resistant than the usual baked textured enamel. In a recent evaluation for food shelves, M&T's *Coating 6400* withstood a half million "rubs" from canned goods and still looked new; the shelf with baked enamel showed wear after only 30,000 abrading strokes from the can.

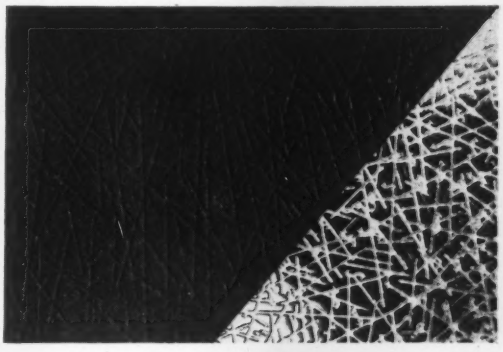
Unichrome Coating 6400 sprayed on smooth metal develops a texture with the appearance of luxurious grained leather.

The inherent chemical resistance in these vinyl coatings also protects against stains and corrosion. Their insulating qualities mean warmth to the touch, and also aid in sound-deadening.

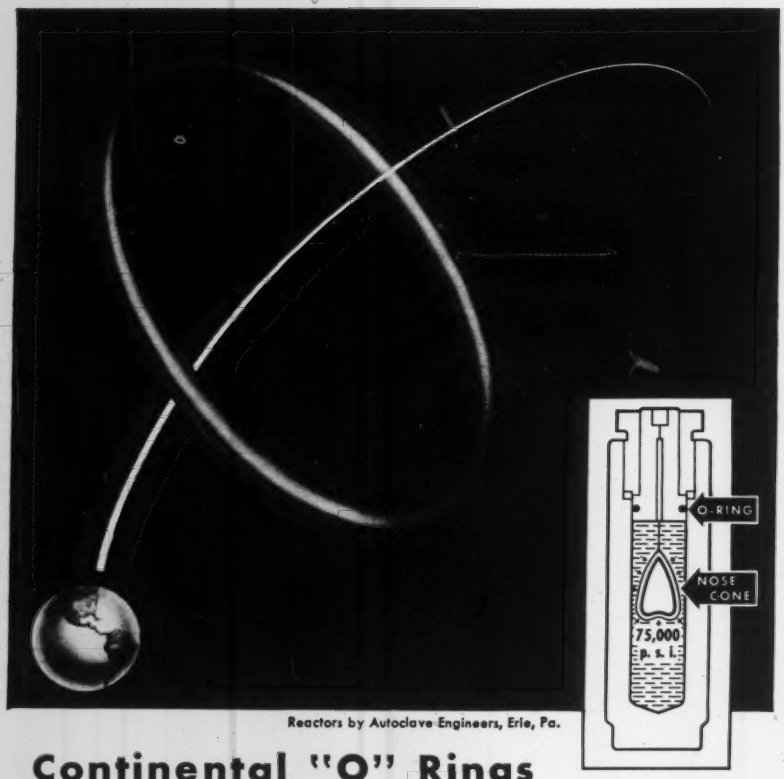
As for production benefits, the sprayed finish eliminates the expensive scrap loss incurred with laminates; it also eliminates seam problems at joints.

For more details, write METAL & THERMIT CORPORATION, Rahway, N. J.

Unichrome Coating 6440, whether sprayed thick or thin, produces an exact replica of the metal pattern beneath it; also contributes warmth, color, and unusual protection.



M&T coatings and finishes
METAL & THERMIT CORPORATION



Reactors by Autoclave Engineers, Erie, Pa.

Continental "O" Rings Help Put Satellites in Orbit

Almost as dramatic as the thrust of a satellite into outer space is the technique used to fabricate the nose cone of the missile. These nose cones, made either of powdered metals or refractory materials, are being compacted in 12" I.D. pressure vessels under hydrostatic pressure of 75,000 P.S.I. *Imagine the problem involved in sealing a vessel against such terrific pressure!*

Yet *THAT* is the problem solved by this Continental "O" Ring. Obviously an ordinary "O" Ring would not do. The job called for a special compound with molecular formation so precise that separation or micro-leakage just could not occur. Continental developed the compound that meets this rigid test. What's more, the elasticity of the rubber refuses permanent set and thus permits re-use of the ring.

This unusual rubber problem typifies the complete engineering service available to you here at Continental. Whether you need molded or extruded rubber parts, consult with us *while your new products are still on the board.* Let us suggest how you might save both tooling and material costs—and get a better product for the job.

Hydrostatic Pressing (see diagram).

A technique for producing uniform compaction and grain structure to obtain super hardness and impact resistance in critical components. A steel forming-mandrel is coated with a refractory material, placed in a rubber bag and suspended in pressure vessel. Pressure is applied until required density is attained.

Engineering catalog.

In addition to custom-made parts, Continental offers an extensive line of standard grommets, bushings, bumpers, rings and extruded shapes. Hundreds of these are shown in the No. 100 Engineering Catalog. Send for a copy or refer to it in Sweet's Catalog for Product Designers.

Another achievement in **RUBBER**
engineered by **CONTINENTAL**

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For more information, turn to Reader Service card, circle No. 453

What's new IN MATERIALS

PROPERTIES OF EPONOX-777

PHYSICAL PROPERTIES	
Specific Gravity	1.25
Water Absorption, %	0.19
MECHANICAL PROPERTIES	
Tensile Strength, psi	14,000
Compressive Strength, psi	26,000
Flexural Strength, psi	20,000
Flexural Modulus, 10^5 psi	4.3
Heat Distortion Temp, F	415
ELECTRICAL PROPERTIES	
Dielectric Strength, v/mil	410
Dielectric Constant	3.95
Volume Resistivity, ohm-cm	10^{15}
Loss Factor	
60 Cycles	0.028
10^6 Cycles	0.086

tropic, it flows evenly over parts being dipped. When parts are withdrawn, the viscosity of the compound increases so that no dripping occurs.

The third new epoxy compound is available from Chemgineers Inc., 5880 Hollywood Blvd., Los Angeles 28. It is called Eponox-777, and is designed for potting, encapsulating, molding, tooling and wire coating. The compound, supplied in powder form, is nontoxic, can be stored at room temperature indefinitely, and is resistant to shock, moisture, and temperatures ranging from 70 to 400 F.

Copper Alloy Competes with Leaded Copper

A new sulfur copper rod alloy is said to be highly competitive with generally used leaded or tellurium copper rod. The alloy contains 0.3% sulfur compared to 1.0% lead in leaded copper and 0.5% tellurium in tellurium copper. It was developed by Bridgeport Brass Co., 30 Grand St., Bridgeport, Conn.

The copper alloy is said to combine high electrical conductivity (averaging 95-97% IACS compared to 99% for leaded copper and 90% for tellurium copper) with good machinability. Its machinability rating of 90 as compared to free-cutting brass is said to be equalled only by tellurium copper among the high copper alloys.

(continued on p 176)

the RIGHT SIZE and SHAPE...

in welded steel tubing

What size do you need? Standard produces welded tubing in a vast range of sizes and grades—stainless, carbon and low alloy. What shape do you need? Standard produces it in round, square, rectangulars, and a host of special shapes. Maybe you have a design problem? The specialists at Standard are anxious to work with you. Whether your requirements call for structural, mechanical, or pressure tubing, Standard produces them to your specifications.

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Write for 8-page folder on all Standard products.

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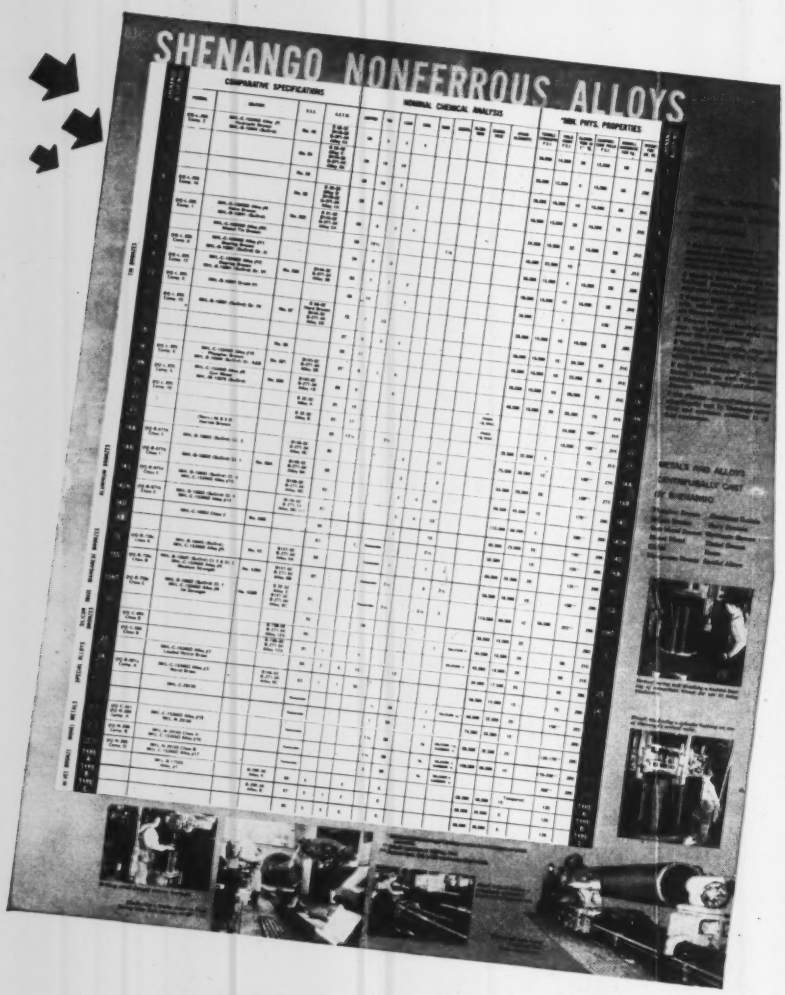
THE STANDARD TUBE COMPANY and MICHIGAN STEEL TUBE PRODUCTS DIVISION

24400 Plymouth Road • Detroit 39, Michigan

Welded stainless tubing and pipe • Welded carbon steel mechanical Boiler and Heat Exchanger • Exclusive rigidized patterns Special Shapes • Oil Well Tubing and Casing • Light Weight Pipe Steel Tubing—Sizes ½" OD to 6" OD—.028 to .270 wall Stainless Pipe and Tubing—Sizes: ¼" OD to 4¾" OD—.020 to .187 wall.

For more information, turn to Reader Service card, circle No. 478



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for ***COMPARATIVE SPECIFICATIONS***
CHEMICAL ANALYSES
MINIMUM PHYSICAL PROPERTIES

...clearly charted in SHENANGO'S new Bulletin No. 157

This invaluable chart of nonferrous alloys centrifugally cast by Shenango is readily available upon request. For your free copy, write to this publication or the Centrifugally Cast Products Division, The Shenango Furnace Company, Dover, Ohio.

SHENANGO CENTRIFUGAL CASTINGS

COPPER, TIN, LEAD, ZINC BRONZES · ALUMINUM AND MANGANESE BRONZES
MONEL METAL · NI-RESIST · MEEHANITE METAL · ALLOY IRONS · DUCTILE IRON

For more information, turn to Reader Service card, circle No. 367

What's new IN MATERIALS

Potential uses

The new alloy is expected to be used for screw machine parts, and such electrical parts as transistor bases, switches and electronic components. The electrical parts may be cold or hot forged, headed or machined.

Bridgeport's sulfur copper alloy is also expected to find use in welding torch tips and soldering tips. According to the developer, there is less wearing away of metal when sulfur copper is used in place of tellurium copper for soldering applications.

How costs compare

Currently, sulfur copper rod sells for 2¢ per lb less than tellurium copper. Clean, heavy sulfur copper scrap is worth about 6½¢ per lb more than corresponding tellurium copper scrap. The developer says this is true mainly because of the relative ease with which sulfur copper scrap can be purified of its sulfur.

Plastics Tubing Made by Continuous Process

Continuous and high speed production of reinforced thermosetting plastics tubing is made possible by a new process developed in France by R. Imbert and P. de Vinzelles. The inventors are represented in this country by the Council on Public Relations, Inc., 366 Madison Ave., New York 17.

In the process, layers of polyester-impregnated fiberglass fabric are formed into rigid tubing in a few seconds by a new "high frequency polymerization" method (details have not been revealed). The tubemaking unit, which can be used in the plant or mounted on a truck and operated in the field, turns out 6 to 8 ft of

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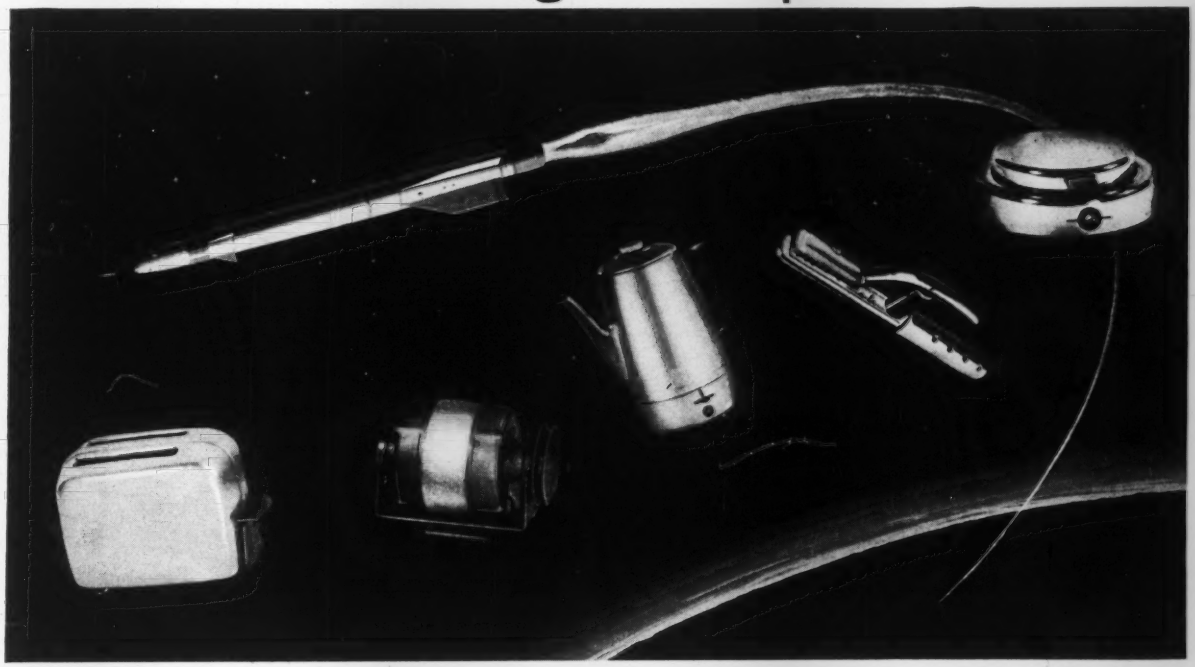
How plastic laminates behave at high temperatures



"How high is up?" to quote an old riddle, just about describes the high temperature possibilities of plastic laminates.

To a missile expert a high temperature might be in excess of 5000°F or of 20,000°F. To many of us high could mean 180°C, or over 250°C.

The key to the situation is Temperature Endurance. Where high temperature resistance is required, as in missile applications, the useful life of the part may be a matter of seconds. Under these conditions recent experiments show that reinforced organic plastics can compete with refractory metals and ceramics. And there are indications that the "old reliable" phenolic resin laminates might outshine the newer resins in this respect.

All of this is exciting yet the larger need is for plastic laminates which will endure moderately elevated temperatures for a long time. The A.I.E.E. defines Class H and Class C materials as those which "by experience or accepted tests" can be shown to be capable of operation at temperatures of 180°C or 220°C respectively.

Tests of 7 standard grades of plastic laminates were made by members of the Laminated Products Section of N.E.M.A. (Table 1).

Obviously, Grades XX and LE are not 180°C material. Grade XXXP has excellent electrical properties after exposure. Grades G-5 and G-7 have excellent mechanical properties and good electrical properties.

Similar tests were made on 4 standard grades at 250°C with these results:

Table 1
Properties at 180°C after 1000 hours exposure to 180°C

Grade	Flexural Strength	Dielectric Strength	
		Perpendicular	Parallel
	psi	V.P.M.	V.P.M.
XX	5600	*	170
XXXP	4100	530	250
LE	400	*	*
AA	5400	55	76
G-5	17500	112	143
G-7	18700	290	200
G-10	5200	160	178

*Specimens blistered

Table 2
Properties at 250°C after 1000 hours exposure to 250°C

Grade	Flexural Strength	Dielectric Strength	
		Perpendicular	Parallel
	psi	V.P.M.	V.P.M.
AA	800	50	54
G-5	1900	108	77
G-7	11800	211	250
G-10	not tested	112	100

These same materials often are satisfactory at temperatures in excess of 5000°F for a number of seconds required in these types of applications.

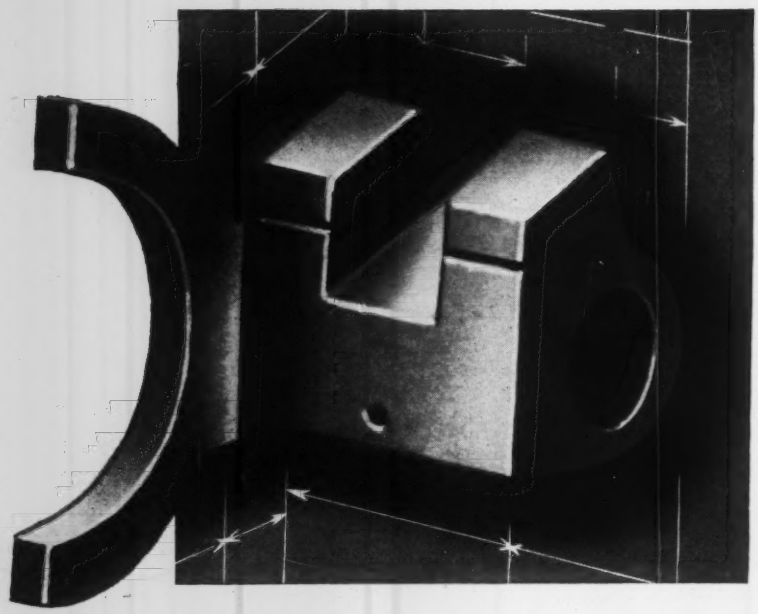
Just as the tests hold great promise for the future of laminated plastics in the very high temperature field, so do the tests in the moderately elevated temperature applications demonstrate the remarkable endurance of plastic laminates.

Consider Other Properties

The thermal resistance and thermal endurance of laminates such as Synthane must be viewed in relation to other properties. Commercial applications include toasters, ironers, space heaters, water heaters, welding equipment, motors, generators, circuit breakers, electric furnaces and ovens, jet engines. These applications may require also resistance to moisture, chemicals, wear, ageing; ease of fabrication, mechanical strength, light weight. Since the life of a laminate in a heat environment may be affected by conditions not present during actual tests, special test procedures may have to be established. Synthane Corporation will be very happy to help you find a laminate suitable for your temperature-life problem. Write Synthane Corporation, 3 River Road, Oaks, Pa.

SYNTHANE CORPORATION, OAKS, PENNA.
Laminated Plastics for Industry
Sheets, Rods, Tubes, Fabricated Parts
Molded-laminated, Molded-macerated

For more information, turn to Reader Service card, circle No. 365



this new part brings outstanding cost reductions...

The photograph is of a shifter fork used in the transmission of a very popular garden tractor in volume production.

Clearly evident is the economy that can be achieved by powder metallurgy over other previously used methods. The elimination of practically all machine work effects striking cost reduction.

Made of pure powdered iron, infiltrated with copper to give added strength and ductility, this part is intended to meet the higher physical properties of wrought metals.

The user of this part naturally presented his problem to Bunting first.

For the unusual, as well as the usual, in bearings, bushings, bars and special parts of cast bronze, sintered metals, or Alcoa aluminum, see Bunting first.

BUNTING SALES ENGINEERS in the field and a fully staffed Product Engineering Department are at your command without cost or obligation for research or aiding in specification of bearings or parts made of cast bronze or sintered metals for special or unusual applications.

...ask or write for your copy of...

Bunting's "Engineering Handbook on Powder Metallurgy" and Catalog No. 58 listing 2227 sizes of completely finished cast bronze and sintered oil-filled bronze bearings available from stock.

The Bunting Brass and Bronze Company
Toledo 1, Ohio EVergreen 2-3451

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Branches in Principal Cities

BEARINGS, BUSHINGS, BARS AND SPECIAL PARTS OF CAST BRONZE OR SINTERED METALS. ALCOA® ALUMINUM BARS

For more information, turn to Reader Service card, circle No. 454

tubing per min. The unit can produce porous or nonporous tubing for use as posts, pipelines and railings.

The tubing is water and oil resistant, and withstands pressures as high as 1500 psi. It has a compressive strength of 2400 psi.

Cobalt Strengthened by Oxide Dispersions

The graph at the bottom of this page shows that the high temperature creep resistance of cobalt is substantially improved by adding chromium oxide dispersions to the metal. The cobalt-chromium oxide composition has only 4% of the total creep elongation of pure cobalt after 250 hr at 932 F and 12,000 psi stress.

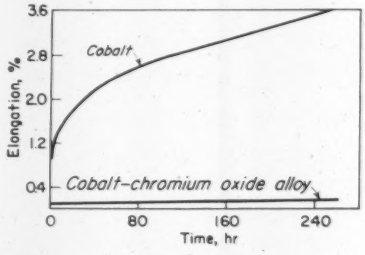
E. F. Adkins, C. T. Sims and R. I. Jaffee of Battelle Memorial Institute, noting that dispersion-strengthening has been applied successfully to copper, zinc, silver, lead, molybdenum and nickel, decided to use the method for improving the elevated temperature properties of cobalt.

Dispersions effective in pure cobalt

The researchers, who described their work in the Apr '59 issue of *Transactions of the Metallurgical Society of AIME*, found that oxide dispersions, although effective in pure cobalt, were much less effective in cobalt alloys.

Other conclusions derived from their study:

1. Oxide particle size is an important factor in obtaining oxide-dispersion strengthening. Of all alloys evaluated, it appears that those con-

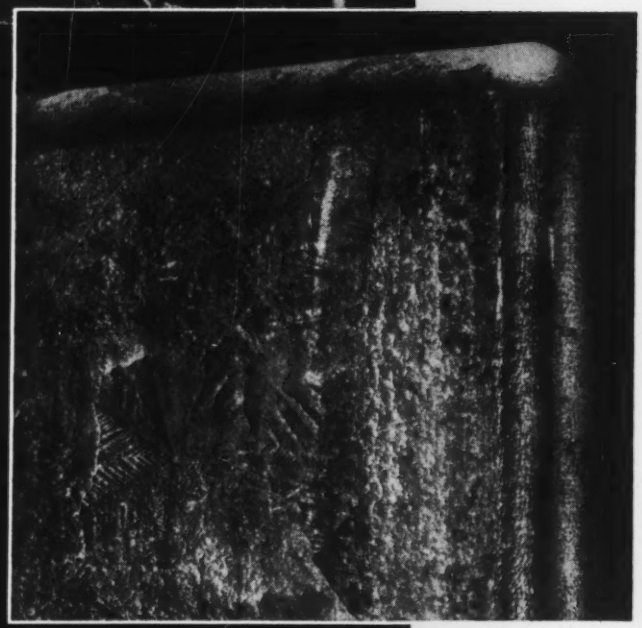


Creep curves *for cobalt and cobalt-chromium oxide alloy tested at 932 F under 12,000 psi.*

Handkerchief fold

on USS Galvanized Steel Sheets

proves the zinc stays on



These are unretouched pictures of twice-folded USS Galvanized Steel Sheets. The sheet in the smaller picture is magnified three times actual size.

We cut a piece from a sheet of USS Galvanized Steel—bent it double—
then we bent it double again.

But look at the zinc coating along the outside of the bend. Not one bit of the coating flaked off! What's more, we restraightened the sheet and still not one speck of zinc came loose!

This kind of adherence means you can fabricate USS Galvanized Steel Sheets in ways you may not have thought possible.

For best results use USS Galvanized Steel Sheets. Call our local sales office or write to United States Steel Corporation, 525 William Penn Place, Pittsburgh 30, Pa.

USS is a registered trademark

United States Steel Corporation – Pittsburgh
Columbia-Geneva Steel – San Francisco
Tennessee Coal & Iron – Fairfield, Alabama
American Steel & Wire – Cleveland
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USS

save machining . . . save material . . . by using

Edgewater rolled steel rings

Simple or complex cross-sections are formed so accurately by the Edgewater process, that machining is greatly minimized. These rings are rolled from solid blocks of steel. Hot working develops greatest strength and toughness in the metal. Diameters from 5 to 145 inches. Materials include carbon and alloy steels, stainless, tool steel, titanium.

Write for descriptive bulletin.

Edgewater Steel Company

Dept. MDE • P.O. Box 478 • Pittsburgh 30, Pa.

For more information, turn to Reader Service card, circle No. 382

taining the finest dispersions had the highest room and elevated temperature properties.

2. An alloy of the L-605 type prepared by powder metallurgy techniques and containing chromium oxide dispersions had considerably higher room temperature tensile and yield strengths than the commercially wrought material. Creep strength, however, was much lower, with creep-rupture occurring after 3.6 hr at 1500 F and 14,000 psi stress.

Dispersion strengthening started with aluminum

Dispersion strengthening is a process of strengthening an alloy by a fine insoluble phase dispersed through the matrix of the parent metal.

The concept of dispersion strengthening was first exploited in Germany with the SAP process (sintered aluminum powder) in which aluminum is strengthened by the presence of dispersed aluminum oxide.

Acrylic Coating Resists Salt Spray, Gasoline

Films of a new water-thinned acrylic emulsion polymer are said to be superior to conventional melamine-alkyd enamels in hardness, impact resistance, flexibility, durability and

PROPERTIES OF RHOPLEX AC-200

COMPOSITION, APPLICATION	
Solids Content, %	53
Pigment-Binder Ratio	60:100
Bake Schedule	30 min at 300 F
MECHANICAL PROPERTIES	
Tukon Hardness (KHN)	18
Pencil Hardness	6H
60-Deg Gloss Value, %	80
Knife Adhesion	Excellent
Impact Res, in.-lb	30
Flexibility (bent over ⅛-in. mandrel)	OK
CHEMICAL PROPERTIES	
Water Res (136 hr, 100 F)	
Rust	None
Blistering	None
Wet Adhesion	Fair
Humidity Res (500 hr, 100% RH)	Unaffected
Detergent Res (16 hr, 165 F, 1% Tide sol'n)	Dulling, scattered blisters

THIS IS GLASS

A BULLETIN OF PRACTICAL NEW IDEAS FROM CORNING

NEW! A MIRROR THAT MAKES HEAT TO BEAT SLEET

You're jockeying a big trailer-truck along a winding road in New England. It's winter and you run into a real storm—a mixture of snow, rain, sleet. You flip a switch and . . .

Your outside rear-view mirror is *clear* in a matter of minutes. From a heavy coating of ice to *all* clear is only a matter of five minutes, even at −20°F.

The mirror, as you might guess, isn't just ordinary glass. It's one of Corning's PYREX brand glasses, and on its surface is an electrically conductive coating that's permanently fired in.

This coating (a metallic oxide) is what turns your mirror into a *heating* element when a current is applied. The heat melts ice and snow, prevents fog or drizzle from condensing on the surface.

If you use EC (electrical-conducting) glass for self-defrosting mirrors you get a bonus, since the coating also provides a non-glare surface.

But don't go away just because you gave up dreaming about driving a truck-and-trailer years ago. This PYREX® electrical-conducting glass comes in a wide choice of applications.

For example, there are some enterprising people who build radiant heaters, both portable and permanent, around such glass panels.

Comfort, safety, and convenience are the big selling points. Comfort because a panel of EC glass is an area *heat* source putting out long waves. Safety because there are no exposed wires or moving parts. Convenience since you have no burning, no need to do extensive remodeling in order to install it.

These same reasons have made PYREX brand radiant heating units attractive to industry—for heating, drying, curing, baking.

And, if you turn a panel of this glass *around*, it becomes an infrared reflector you can see through—blocking heat but still passing about 75% of the visible light.

Facts? Ask for PE-34, a 4-page data sheet, and/or PE-60, all about industrial heating units. Please use the coupon.

HOW NOT TO FOUL UP THE WORKS

It's really very simple: If you're using spun insulation in electric motors, you have to keep the stuff from falling into the moving parts and fouling up the works.

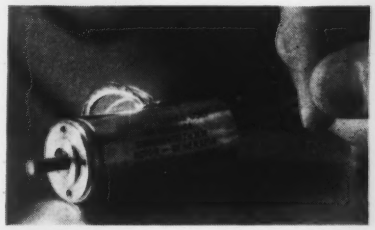
Two things to keep in mind when selecting a material for this application: (1) It has to stand up to quite a bit of heat. (2) It *can't* be a conductor.

Some materials that are good insulators can't take the heat. Others function well at high temperatures but are not insulators.

Glass solves both problems. So, people who make electric motors build them with wedges made from PYREX brand glass No. 7740. (We supply the glass in rod form.)

This particular PYREX brand glass offers a number of useful characteristics. It is corrosion resistant and has a linear coefficient of expansion of 32.5 x 10^{-7} in/in between 0° and 300°C. Dielectric properties at 1 Mc and 20°C. are as follows:

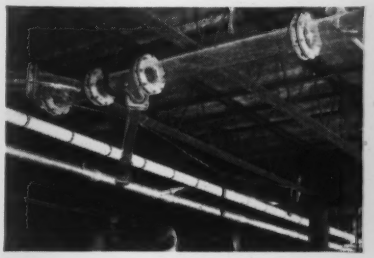
Power factor	.46
Dielectric constant	4.6
Loss Factor	2.1



Wedges made from glass rod support spun insulation in electric motors. Glass is non-conducting and able to stand high temperature without deforming.

You can get PYREX brand glass No. 7740 in a variety of forms—pressed ware, blown ware, plate, tubing, rod and panels.

Mechanical, thermal, electrical, and chemical properties of this glass and 27 others are spelled out in Bulletin B-83. Check the coupon for a copy.



PLUMBING FOR POSTERITY

An increasingly popular fixture in labs, hospitals, schools, chem plants, and photo-engraving shops is the glass drainline.

With good reason. Glass drainlines are fashioned from PYREX brand glass No. 7740.

This is the glass that ends your worries about corrosion. For example, if you were disposing of waste hot hydrochloric acid, your PYREX pipe would still be around at the end of 200 years.

And glass is smooth; very little chance for block-up in the pipe. If such does occur, however, you can spot the exact point and take corrective action, without having to take down the whole system.

In fact, almost anything made from PYREX brand glass No. 7740 will be around for quite a while because this glass is able to cope with thermal shock and physical knocks, too.

Available in many forms—tubing, rod, pipe, plate, and all kinds of shapes.

Fill in the gaps in your files with these basic references: PE-30, all about glass drainlines; IZ-1, design considerations in glass. Any or all, free. Use the coupon.

MORE ON PYROCERAM*

Developments in our new crystalline materials made from glass are treated at length in the third Pyroceram Progress Report. See coupon.

*Trade Mark

CORNING MEANS RESEARCH IN GLASS

CORNING GLASS WORKS 50 Crystal St., Corning, N. Y.

Please send me: ☐ PE-60, booklet on heating units; ☐ B-83, "Properties of Selected Commercial Glasses"; ☐ IZ-1 Design Manual; ☐ PE-30 Drainline Manual; ☐ Pyroceram Progress Report No. 3; ☐ PE-34, "Corning Flat Glasses."

Name ..... Title .....

Company .....

Street .....

City ..... Zone ..... State .....

For more information, turn to Reader Service card, circle No. 405

These small

MORGANITE

CARBON-GRAPHITE-WITH-METAL

CONTACTS

—can prevent costly equipment failures

FOR EXAMPLE, MORGANITE ELECTRICAL CONTACTS INSTALLED IN MAIN AND AUXILIARY CONTROLS WOULD HAVE PREVENTED THIS BRIDGE FAILURE

BRIDGE SLOWS SIX TRAINS

Traffic Waits for Stuck Drawbridge

Four passenger trains and two freight trains were delayed yesterday up to thirty-eight minutes when a main line drawbridge remained open through electrical failure.

The trouble, which began about 3:40 P.M., was not cleared up by 4:15. Normal service was maintained during the commuter rush period, according to a road spokesman. Inbound and

MORGANITE self-lubricating contacts and current collectors are non-welding. They improve electrical conductivity and reduce operating costs because of *minimum* maintenance requirements. MORGANITE electrical components, and self-lubricating mechanical carbons, have solved difficult design problems in thousands of commercial and military applications. For data on your specific requirements, call or write MORGANITE, today!

MEMO:

—to Designers/Engineers

Specify Morganite PY4 Seal Noses for Exceptional Service Life in Equipment Handling Grease, Searching Liquids, Corrosives, High Pressures and Temperatures.

Morganite

INCORPORATED . . . FOR OVER HALF A CENTURY

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Manufacturers of Fine Carbon Graphite Products including Mechanical Carbons, Motor/Generator Brushes, Carbon Piles, Current Collectors and Electrical Contacts . . . Distributors of 99.7% Pure Al_2O_3 Tubes and Crucibles

For more information, turn to Reader Service card, circle No. 435

What's new IN MATERIALS

adhesion. The material is also said to be in the same class with melamine-alkyd enamels with respect to water, detergent, salt spray, humidity and gasoline resistance.

The acrylic polymer, called Rhoplex AC-200, was developed by Rohm & Haas Co., Resinous Products Div., Washington Square, Philadelphia 5.

Clear films of the coating are expected to give long lasting protection to the polished surfaces of aluminum, bronze and brass, and chromium electroplates. Pigmented coatings are expected to be used on automobiles, appliances, steel drums, machinery, motors and metal furniture.

According to Rohm & Haas, optimum hardness, gloss, adhesion and color retention of Rhoplex acrylic enamels are obtained by baking for 30 min at 300 F. Water resistance and similar properties can be improved by baking for 30 min at 350 F.

(For more information on water-thinned acrylic paints, see M/DE, May '58, p 102.)

Other News . . .

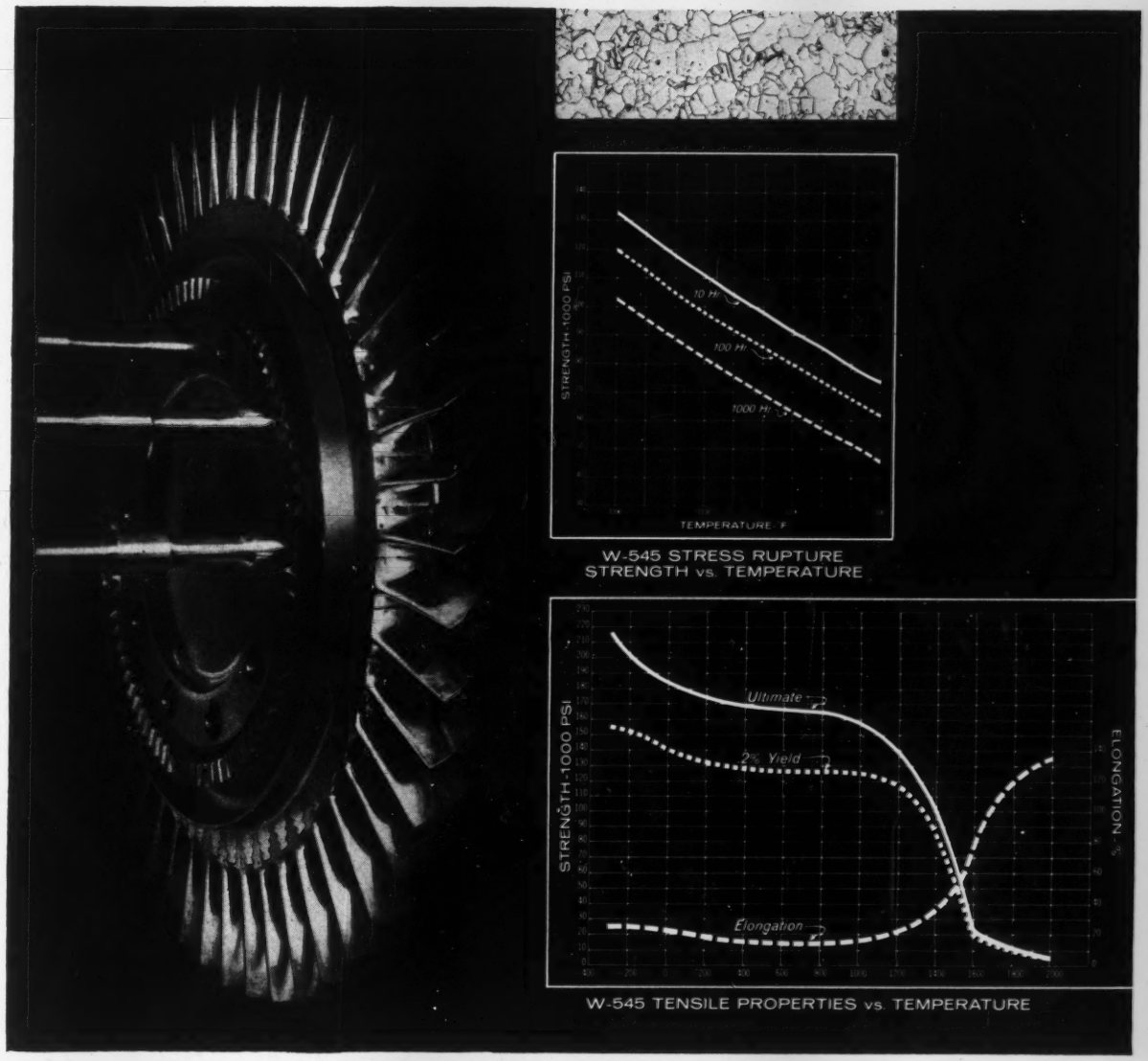
Metals

▸ A permanent magnet material called Alnico VII A is designed for use in magnetic core meter and instrument applications. The nonferrous material is said to have an extremely high coercive force. It is available from Indiana Steel Products Co., Valparaiso, Ind.

▸ A specially processed, high strength 70:30 copper-nickel alloy tube has been designed for high temperature feed water heaters and other heat exchanger applications. The tubing material has a minimum tensile strength of 72,000 psi and a minimum elongation of 15%. The tubing is marketed by Chase Brass & Copper Co., 236 Grand St., Waterbury 20, Conn.

▸ A slide rule for computing the weight of ferrous and nonferrous forgings, rings, bars and other shapes is being marketed by Novotni Slide Rule Co., Media, Pa.

▸ Aluminum alloy 6063 extrusions are supplied by Harvey Aluminum Co., 19200 S. Western Ave., Tor-



W-545 STRESS RUPTURE STRENGTH vs. TEMPERATURE

W-545 TENSILE PROPERTIES vs. TEMPERATURE

NEW HIGH-TEMPERATURE ALLOY W-545 HAS 20% MORE STRENGTH

Twenty percent more strength at 1200°F from this turbine disc gave added dependability for a Westinghouse customer using W-545. This new high-temperature alloy will withstand higher stress levels than similar alloys at the same operating temperatures . . . or it will withstand equivalent stress characteristics at 100°F higher operating temperatures.

Critical high-temperature parts can be made from this material that have excellent strength-to-weight ratios and can be used at temperatures up to 1350°F . . . excellent characteristics at —300°F.

W-545 has proven itself superior for turbine wheels . . . compressor discs and shafts . . . combustion chambers . . . housings and skin materials. W-545 is nonmagnetic and has a low strategic alloy content, permitting ease of fabrication for fasteners . . . rings . . . spacers . . . fittings . . . brackets . . . supports and mounts.

The Westinghouse Metals Plant can furnish strip, sheet, bar, forgings and forging stock in W-545 and other wrought high-temperature alloys. Get all the information today; write: Westinghouse Electric Corporation, Materials Manufacturing Department, Blairsville, Pennsylvania.

J-05010

YOU CAN BE SURE...IF IT'S

Westinghouse

WATCH "WESTINGHOUSE LUCILLE BALL-DESI ARNAZ SHOWS" CBS TV FRIDAYS

For more information, turn to Reader Service card, circle No. 473

makes Fluoroflex®-T pipe permanently corrosion-proof

USING the pipe lining *material* that handles highly corrosive fluids is only half the job. Keeping it *in place*, despite wide temperature fluctuations, is equally important. Fluoroflex-T Type S piping solves both problems . . . assuring unequalled pipe and fitting life.

Lining is universally inert to all corrosives. It's made of Fluoroflex-T, a high density, non-porous compound* of virgin Teflon.

Liner and housing in thermal equilibrium, through an exclusive process developed by Resistoflex. It compensates for thermal expansion differential between the Teflon and housing, eliminating fatigue collapse, and cracking at the flare.

Bulletin TS-1A gives more details. Write Dept. 412, RESISTOFLEX CORPORATION, Roseland, N. J. Other plants: Anaheim, Calif.; Dallas, Tex.

* *Pat. No. 2,752,637*

®Fluoroflex is a Resistoflex trademark, reg., U.S. pat. off.
®Teflon is DuPont's trademark for TFE Fluorocarbon resins.

RESISTOFLEX

For more information, turn to Reader Service card, circle No. 449

What's new IN MATERIALS

rance, Calif. with a coating for protection against superficial corrosion during shipping, storing and handling. The coating, called Anocote, does not alter the natural color of aluminum, according to the producer.

▸ Bimetallic condenser and heat exchanger tubes for applications involving different internal and external corrosive operating conditions are now available from Chase Brass & Copper Co., Waterbury 20, Conn. The tubes are manufactured in a variety of combinations of ferrous and nonferrous metals.

▸ A steel safety grating is made from descaled, skid-proofed steel bars formed into honeycomb and welded by a "hydroelectric pressure" method. The grating, called Protecto, was developed by Bustin Steel Products, Inc., Dover, N. J.

Plastics

▸ A hot melt potting compound for power transformers has been developed by Biwax Corp., 3445 Howard St., Skokie, Ill. The material, called B-1317, has good adhesion to metal and a low coefficient of thermal expansion. Composition has not been revealed.

▸ Odorless, nontoxic and moisture resistant pipe coverings are now available from United Cork Companies, Central Ave., Kearny, N. J. The coverings, made of expanded polystyrene, are supplied in thicknesses of 1, 1½ and 2 in.

▸ Heavy gage, seamless polyethylene sheet is now available from Gering Plastics Co., Div. of Studebaker-Packard Corp., North 7th St. & Monroe Ave., Kenilworth, N. J. The sheet is supplied black or clear in 20, 28 and 32-ft widths.

Other nonmetallics

▸ A neoprene rubber-coated nylon fabric is specially designed to withstand the rapid flexing and temperature buildup encountered in air compressors. The material is available from Reeves Bros., Inc., 1071 Avenue of the Americas, New York 18. It is called Reevecote 7358.

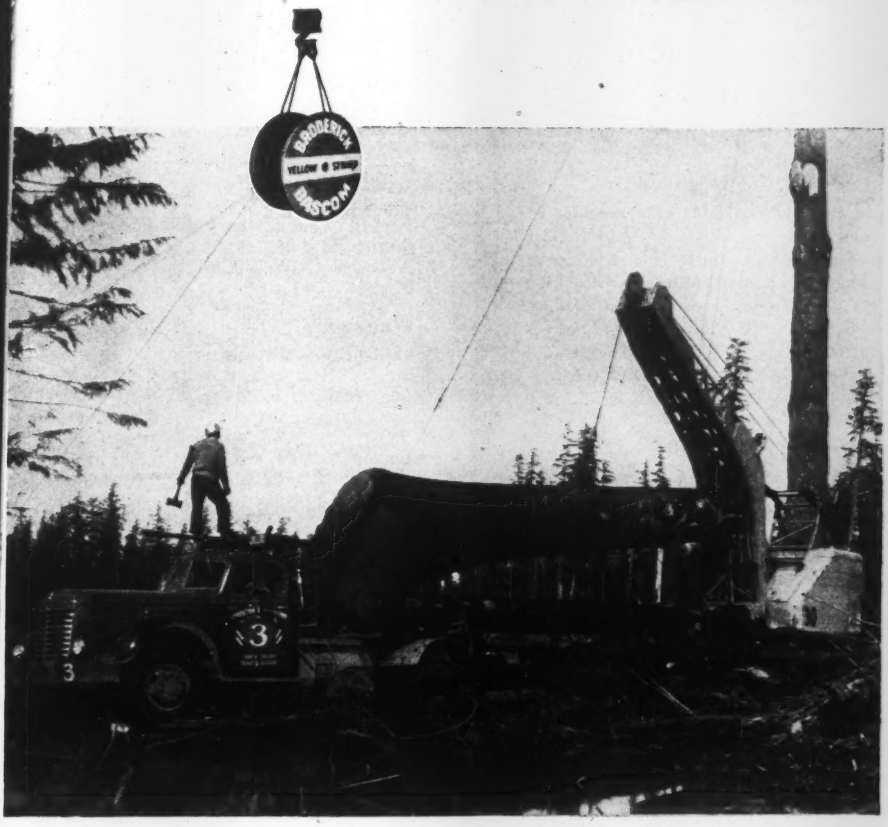
▸ A dry lubricant for cryogenic use is said to have good wear resistance properties at temperatures from —300 to 1000 F at bearing loads up to 50,000 psi. The product, called No. 811, was developed by Everlube Corp. of America, 6940 Farmdale Ave., North Hollywood, Calif.

(more news on p 186)

Youngstown Rope Wire
passes through preforming head and closing die, to become Broderick & Bascom's famous "Yellow Strand" wire rope.

Accent on Excellence

Youngstown rope wire



Lifting a mighty fir or a stalled automobile, a sling of wire rope is tough to beat for speed, safety and handling ease. Long experience, sound engineering and only the best materials—that's what it takes to make a good sling, and Broderick & Bascom makes them for almost every lifting job you can name.

This leading maker of slings and wire rope never compromises with quality. They count on Youngstown Rope Wire to uphold their reputation—*and it does.* Broderick & Bascom "Yellow Strand", and extra high-strength "POWERSTEEL" wire rope are made of Youngstown Rope Wire that consistently meets the most exacting quality standards.

Wherever steel becomes a part of things *you* make, the high standards of Youngstown *quality*, the personal touch in Youngstown *service* will help you create products with an "accent on excellence".

The Youngstown Sheet and Tube Company, Youngstown, Ohio.
Carbon, Alloy and Yoloy Steel.

Youngstown

QUALITY YOUNGSTOWN SERVICE

For more information, turn to Reader Service card, circle No. 362

Chace THERMOSTATIC BIMETAL

ACTUATES ANOTHER PRECISION PRODUCT

The Therm-O-Disc ADJUSTABLE FURNACE FAN CONTROL

Thermo-O-Disc, Inc. Mansfield, Ohio

The Type AF-3 Adjustable Furnace Fan Control is a new product of Therm-O-Disc, Incorporated, for use with (or without) their similar adjustable or non-adjustable Furnace Limit Controls. This equipment stresses dependability, thermal sensitivity, and trouble-free life, plus adjustability within a range of 90°. The pointer indicates the turn-on temperature of the blower. Its snap-acting switch mechanism and heavy-duty contacts provide high electrical ratings up to 300°F., with full load amperages of 8.0 and 4.0 at 115 v. and 230 v. respectively. The control is listed by UL and C.S.A. An outstanding feature is the Chace precision bimetal sensing element which is mounted well into the air stream and provides quick response to temperature change.

In our more than a third of a century as producers of precision thermostatic bimetal, we've known and supplied hundreds of manufacturers of temperature actuated devices. Many have come from modest beginnings to become important factors in their industries and important customers of W. M. Chace Company. We are grateful, not only for their continuous patronage, but also for the millions of opportunities their combined sales have given us. For each product in the hands of a consumer is another chance for us to prove to our customer that his choice of Chace Thermostatic Bimetal was a good one. Whether he buys coils, strips or completely fabricated elements or assemblies of his design, he knows he can launch his new product with complete assurance, if the actuating element is Chace Thermostatic Bimetal.

While your new temperature actuated device is in the preliminary design stage, send for our booklet, "Successful Applications of Chace Thermostatic Bimetal." It's full of design engineering data with illustrated examples of uses of bimetal. Remember, too, that our 29 types of precision bimetal are available in strips, coils or completely fabricated elements of your design.

IT BENDS WITH THE HEAT

W. M. CHACE CO.
Thermostatic Bimetal
1615 BEARD AVE., DETROIT 9, MICH.

For more information, turn to Reader Service card, circle No. 465

What's new IN MATERIALS

▸ The Crystal Products Dept. of Linde Co., Div. of Union Carbide Corp., 30 E. 42nd St., New York 17 is marketing single-crystal yttrium iron garnet. The crystals, used in solid state devices, are grown by a flame fusion technique.

▸ U. S. Sonics Corp., 625 McGrath Hwy., Somerville, Mass., has introduced a new ceramic transducer element that has a constant resonant frequency at temperatures up to 390 F. The material, called US600, has a dielectric constant of 1350.

▸ A line of rigid and semi-rigid insulating felts has been introduced by United States Mineral Wool Co., Stanhope, N. J. The felts are composed of inorganic mineral fibers mill-formed to specific densities and thicknesses with a thermosetting resin.

▸ A high temperature molybdenum disulfide lubricant is available for use on oven conveyors, gears, bearings, glass machinery and kiln cars. Called 'dag' 207, it was developed by Acheson Colloids Co., Port Huron, Mich.

Finishes

▸ A lacquer for coating polyethylene housewares, toys, novelties, displays and sheeting has been introduced by Rubba, Inc., 1015 E. 173rd St., New York City. The lacquer, called Rubbalac, is flexible, dries in a few minutes, and has good abrasion resistance.

▸ A plastics coating has been developed for use in the chemical milling of steel, aluminum, titanium, nickel, magnesium and other metals. Called Metal-Etch Resist, it is marketed by Eastman Kodak Co., 343 State St., Rochester 4, N. Y.

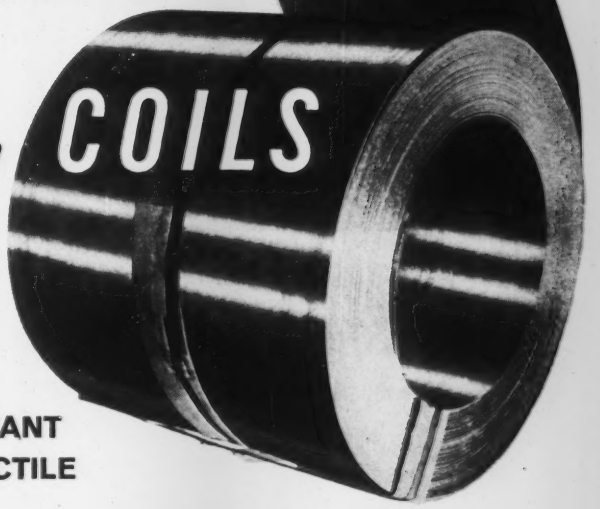
Joining, heat treating

▸ An acetate cement with a flash point above 100 F is designed for safe bonding of acetate and butyrate parts. The acetate cement is commercially available from Schwartz Chemical Co., Inc., 50-01 2nd St., Long Island City 1, N. Y.

▸ A refractory-free, high temperature vacuum furnace has been introduced by General Electric Co.'s Industrial Heating Dept., Schenectady 5, N. Y. The furnace is constructed with three radiation shields surrounding the load. The shields are said to provide thermal insulation by reflecting heat back into the load.

GALVANIZING

Gives You
Even More In COILS



Yes, you get the basic advantages of continuous-line galvanized sheet metal:

A CORROSION-RESISTANT ZINC COATING AS DUCTILE AS THE STEEL BASE

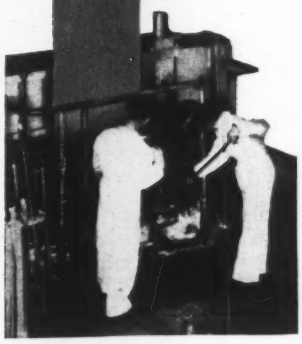
You can

But you can't **FLAKE IT** **CHIP IT** **PEEL IT** **CRACK IT**

AND THE DIVIDEND

In Coil Form, you

- **SAVE STORAGE SPACE**
- **SLASH HANDLING COSTS**
- **REDUCE SCRAP LOSSES**
- **ELIMINATE SHEET END TRIMMING**
- **CUT ODD SHEET INVENTORIES**



Exit end of continuous galvanizing line

The St. Joseph Lead Company is in the unique position of being able to supply zinc to virtually any specification which operators of continuous galvanizing lines consider most desirable for their individual requirements.

ST. JOSEPH LEAD COMPANY

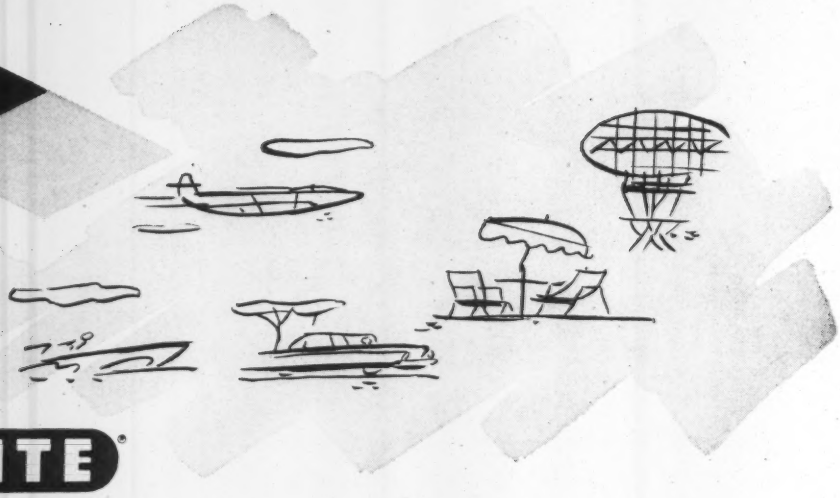
ST. JOE

250 PARK AVENUE
NEW YORK 17, N. Y.

ZM-127

For more information, turn to Reader Service card, circle No. 480

LOOK FOR THE DIAMONDS—SIGN OF FINISHING QUALITY



Only IRIDITE®

Process Engineered Chromate Conversion Coatings

Give you 5 additional benefits for Corrosion Protection—Paint Base—Decorative Finishing

1 A COMPLETE PROCESS ENGINEERED LINE

Developed for specific applications, there is an Iridite to provide the finish you desire, fit the equipment you have available and give the performance you require. Most Iridite coatings meet rigid military and civilian specifications.

2 EXPERIENCED TECHNICAL SERVICE

Our large field engineering staff is thoroughly familiar with chromate conversion coatings and related finishing operations. They'll help you check every step in your finishing operation to make sure you're getting the best possible finish on your products.

3 PRODUCT AVAILABILITY

Warehouses located in strategic industrial areas enable us to provide you with fast, economical delivery on any Iridite.

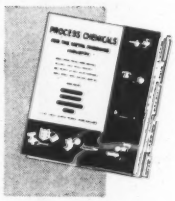
4 ECONOMY

The superior performance of Iridite provides low final cost by extending operating life and lowering maintenance costs. In addition, Iridite gives you a finish that adds considerably to the value of your product. There's an Iridite to meet every cost and performance requirement.

5 RESEARCH AND DEVELOPMENT FACILITIES

If you have an unusual application, we will gladly work with you. Our entire staff of experienced engineers and chemists, and our completely equipped facilities are at your service.

IRIDITE—a specialized line of chromate conversion coatings for non-ferrous metals. Apply by dip, brush or spray methods — at room temperature — manually or with automatic equipment. Forms a thin film which becomes an integral part of the metal. Cannot chip, flake or peel. No special equipment, exhaust systems or specially trained personnel required.



If you are using chromate conversion coatings to finish zinc, cadmium, aluminum, magnesium, silver, copper, brass or bronze — consider the above benefits of Iridite. For complete information, contact your Allied Field Engineer. He's listed under "Plating Supplies" in the yellow pages. Or, write for FREE TECHNICAL DATA FILE.

Allied Research Products, Inc.

4004-06 EAST MONUMENT STREET • BALTIMORE 5, MARYLAND
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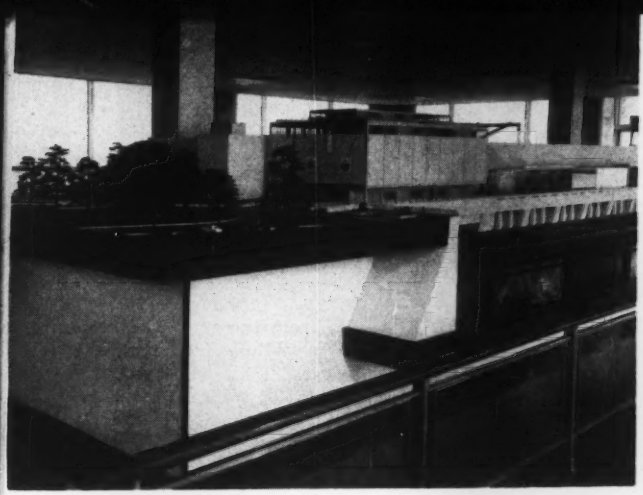
West Coast Licensee for Process Chemicals: L. H. Butcher Co.

Chemical and Electrochemical Processes, Anodes, Rectifiers Equipment, and Supplies for Metal Finishing

IRIDITE® Chromate Coatings	IRILAC™ Clear Coatings	ISOBRITE® Plating Brighteners	ARP® Chemicals & Supplies	WAGNER Line of Equipment

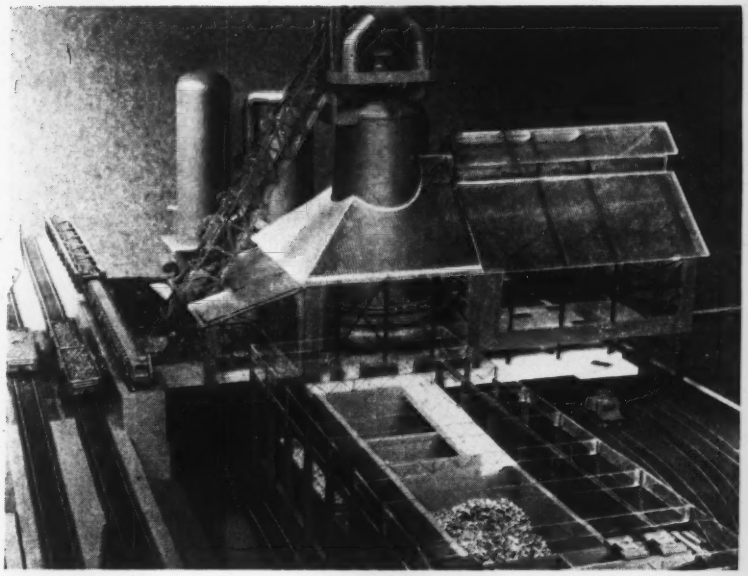
For more information, turn to Reader Service card, circle No. 472



Administration building and dam.

MATERIALS AT WORK

cont'd from p 12



Steel mill blast furnace.

Acrylic Models for Parts, Plants

The use of models is becoming an increasingly popular shortcut to the solution of problems in the design of complex equipment. Of all materials used for these models, which range from massive 8 x 43 ft reproductions of the entire St. Lawrence Valley to tiny subminiature aircraft components, plastics are by far the most popular. And the most frequently used plastic is acrylic.

According to Lester Asso., Inc., acrylic is ideal for modelmaking because it 1) is easily machined to close tolerances; 2) is strong and lightweight; 3) is dimensionally stable; 4) is easily joined; 5) is easily formed (by heat) into intricate shapes; 6) can be patterned for special effects; and 7) has excellent light transmitting characteristics.

Typical of the acrylic models fabricated by Lester Asso. are the administration building and dam, and the steel mill blast furnace, shown in the accompanying photos. The administration building and dam model, which is 6 x 9 x 40 ft long, is animated and moves in unison with a tape recorded commentary.

Model saves $1,000,000

The steel mill model, made entirely of acrylic, is a good example of how models can solve problems before it's too late. The model cost the steel company about $10,000; however, it pointed up the need for some design changes which ultimately saved the company about $1 million a year.

Other acrylic models built by

STRAITS TIN REPORT

News of developments in the production and uses of tin

MALAYAN TIN BUREAU

A giant 55-gal. tin can is being successfully used to pack and ship fruit and vegetable concentrates. It might even replace the conventional No. 10 size tin can which has for so long supplied the food remanufacturing market. Lining is of electrolytic tin plating. A special centrifugal spray process permits application of enamel over the tin-plate.

Corrosive attack under severe atmospheric conditions is a serious problem now solved by two tin alloy coatings. A 75 tin-25 zinc coating has been used with considerable success on hydraulic brake parts and landing gear equipment. 25 tin-75 cadmium coated on reciprocating engine parts overcomes low corrosion resistance of normal steels.

Organotin compounds, such as dibutyl tin dilaurate, are added as stabilizers to vinyl plastic sheet to make it heat- and light-resistant when used as windows.

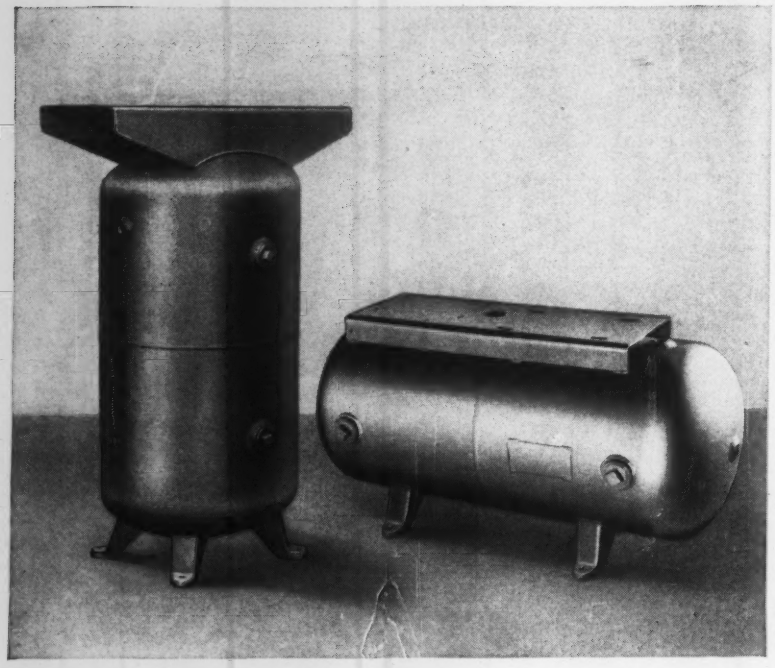
A tin-plate printing machine handling 4-color work is reported by a British firm. It will inexpensively print full-color labels directly onto all sizes of cans up to one gallon in a single operation. The labels will withstand great extremes of temperature.

Write today for more data on these items or for a free subscription to TIN NEWS—a monthly bulletin on tin supply, prices and new uses.

The Malayan Tin Bureau

Dept. 24M, 1028 Connecticut Ave., Washington 6, D.C.

For more information, circle No. 383



Specify Hackney air receivers in standard capacities to cut costs

Did you know that Hackney air receivers are made in *six standard capacities*. That they can be supplied in *quantities* on a schedule geared to *your* assembly operations?

These are two of the cost-cutting advantages you get when Hackney air receivers are specified. Others are:

- Stronger, lighter construction than tanks having longitudinal and two head welds. Meet demands of all pressure vessel codes.
- Made with two smooth, seamless shells—cold drawn to exact diameters and uniform wall thicknesses.
- One circumferential weld...seamless heads...no longitudinal weld, no head welds.
- X-ray inspection of lone seam for soundness and uniformity.
- Heat-treated to obtain desirable physical characteristics.
- Prime coat applied that resists rust, corrosion, abrasions...can be finished to your specifications.

Capacities: Standard horizontal—30, 60, 80 and 120 gallons. Standard vertical—60 and 80 gallons. Special capacities and construction features made to order.

For complete specifications and dimensions, send for our new air receiver bulletin, No. AR.

Pressed Steel Tank Company

Manufacturer of Hackney Products Since 1902

1442 S. 66th Street, Milwaukee 14, Wisconsin

Branch offices in principal cities

Hackney MILWAUKEE DOMINGTOWN IRON WORKS

CONTAINERS AND PRESSURE VESSELS FOR GASES, LIQUIDS AND SOLIDS

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Lester Asso. include: full-sized rocket engine mock-ups; 20-ft replicas of cruisers and tankers; valves, computers and earth satellites; and various training aids and devices for the Navy.

The acrylic plastic is supplied by Commercial Plastics & Supply Co.

Zinc Alloy Dies Outlast Steel in Stamping

Zinc alloy dies are now being successfully used in place of steel dies in some metal stamping operations.

According to Martin Co., the zinc dies are tougher and require less frequent replacement than the conventional steel dies. The new Formaloy dies (produced by Federated Metals Div., American Smelting & Refining Co.) are useful for either short run operations on steel parts or large quantity runs on complex aluminum parts. According to Martin, previously used steel dies often had to be replaced before a long aluminum run was completed.

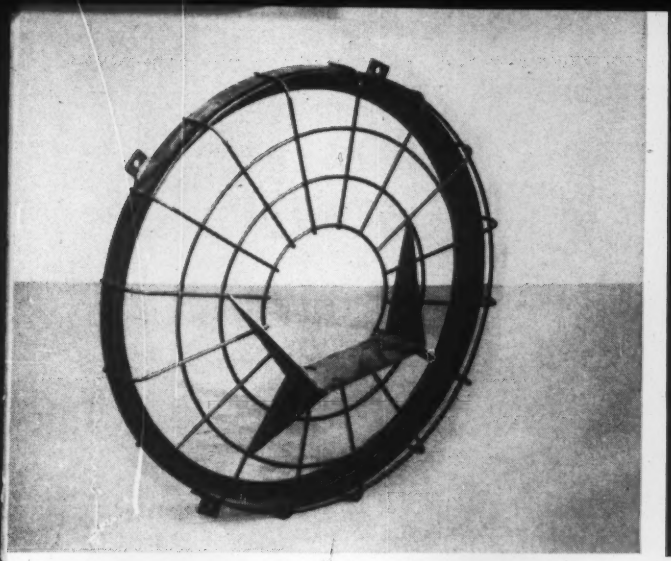
Because the zinc alloy dies provide savings in both time and money —particularly in the changing of damaged dies—they are expected to find wide usage for stamping applications in the aircraft, automotive and machine tool industries.

Filled Nylon Sleeves Cut Maintenance Costs

The switch from phenolic to molybdenum disulfide-filled nylon has resulted in a 75% reduction in time required for repair and maintenance of arbor sleeves used to hold collapsible aluminum tubes in a printing operation.

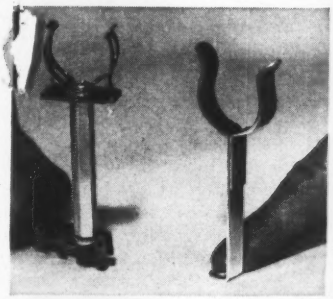
The collapsible tubes, used to package toothpaste, paint, foodstuffs, etc., range in size from ¾ to 1½ in. in dia. When fed to the printing machine, the tubes are perfectly dry inside and out and are extremely soft. An operator lifts a tube off a peg and slides it onto a printing arbor. The arbor then rotates the tube into the proper position for offset printing.

According to Atlas Collapsible



MOTOR MOUNT AND GUARD for a transformer cooling fan. The all-wire piece, right, reduced cost to one third of former price, and weight from 24 lb to 13½ lb. The ¼-in. and 5/16-in. welded steel wire design, replacing the strip, wire frame, and cast rim assembly, also allowed closer tolerances.

How redesigning with steel wire



BRACKET to hold two-way radio plugs on chassis. Cost reduction was 75 pct and weight savings 50 pct when the complicated six-part assembly was eliminated. Manufacturing time of this simple, two-part, ⅜-in. x 1/16-in., flat steel wire design, right, was considerably reduced.

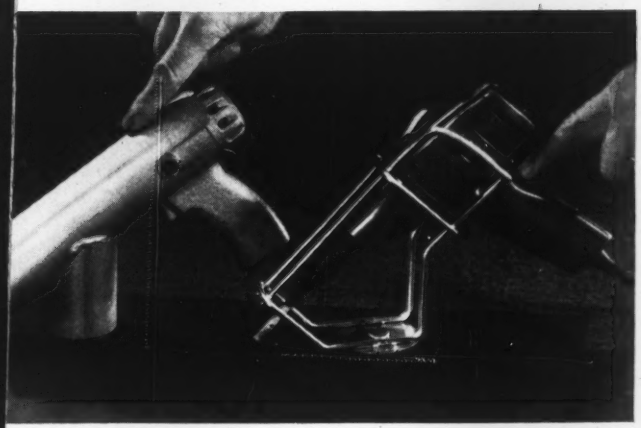
. . . cuts costs

. . . adds strength

. . . saves time

. . . reduces weight

HOLSTER for electric tool. The open wire frame reduced weight by 10 pct and cost by 66 pct. Replacing the welded tubing part, left, this steel wire assembly lends versatility in that it fits several types of tools.



These four examples show clearly why engineers and designers so frequently turn to steel wire for lower costs, simpler designs, and faster production.

Bethlehem makes wire for literally thousands of uses: upholstery spring wire, wire for cold-heading, wire for welded products, wire for handles, communications wire, etc. We regularly produce many grades of steel wire, with various coatings, processed in many ways to meet specific application requirements. Whether you need an ordinary or a special-purpose grade—our modern wire mills can produce it.

Our wire experts are at your service. A letter or call to your nearest Bethlehem sales office is all that's necessary.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

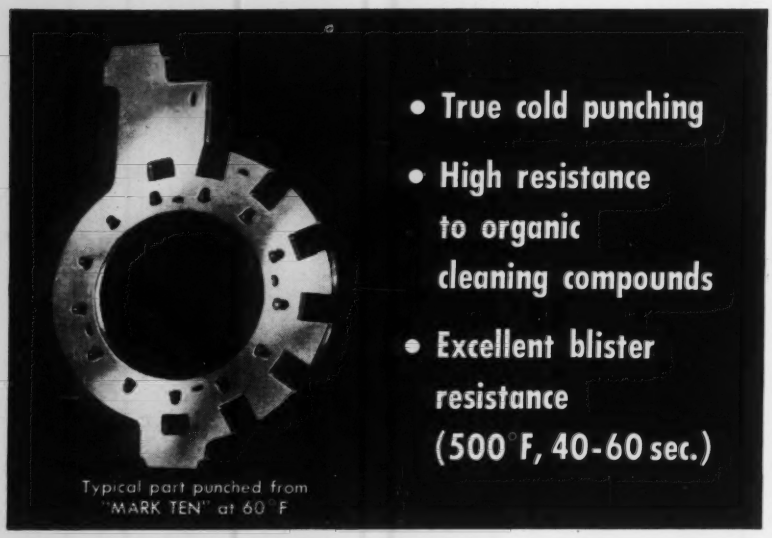
Export Distributor: Bethlehem Steel Export Corporation

These case histories were furnished through the courtesy of E. H. Titchener and Co., Binghamton, N. Y., a regular user of Bethlehem wire.

BETHLEHEM STEEL

BETHLEHEM STEEL

For more information, turn to Reader Service card, circle No. 470


• True cold punching
• High resistance to organic cleaning compounds
• Excellent blister resistance (500°F, 40-60 sec.)
Typical part punched from "MARK TEN" at 60°F

RICHARDSON'S RADICALLY NEW LAMINATE

MARK TEN*

Combined Properties Ideal for Copper-Clad

Here is a radically new and different series of laminated insulating materials known as the "MARK TEN" series. This series of laminates has unique properties which are *chemically built-in* and are not degraded during normal manufacturing processes. Rigidity and flexural strength are high as compared with other cold punch laminates. Intricate shapes can be punched at room temperatures and lower.

As a copper-clad laminate, "MARK TEN" 10-01 introduces the most unusual combination of properties ever known to the laminated plastics field. Besides being a true cold punch material it has unusual resistance to organic cleaning compounds . . . it withstands blistering in solder at 500°F for 40-60 seconds or at 550°F for 10-20 seconds . . . and it averages 7-9 lbs. bond strength.

This "MARK TEN" laminate is chemically engineered with the printed circuit manufacturing process in mind and is designed for most efficient production of printed circuits as well as other products.

"MARK TEN" 10-01 is Richardson's latest addition to its well known line of INSUROK® laminates. As the first grade in this series, it is available both plain and copper-clad. Exceeding NEMA XXXP and MIL-P-3115B Type PBE-P requirements, "MARK TEN" 10-01 has excellent stability in both dimensions and electrical properties over a wide temperature range.

You are invited to request further information and a sample. Write . . . or phone today . . . Chicago phone MA 6-8900.

*A Trademark of The Richardson Company

THE RICHARDSON COMPANY

LAMINATED AND MOLDED PLASTICS — FOUNDED 1858

DEPT. 43 • 2782 LAKE ST. • MELROSE PARK, ILL. • SALES OFFICES IN PRINCIPAL CITIES

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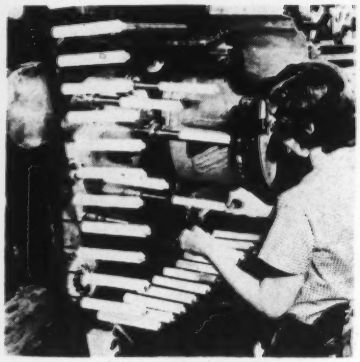


Polymer Corp. of Pennsylvania

***Collapsible tubes** are fed to printer on filled nylon sleeves.*

Tube Co., the tubes must slide easily onto the arbor because any drag or resistance will cause the tubes to crumble. The tolerance between the tube's i.d. and the arbor's diameter is particularly critical, because the arbor must support the entire surface of the tube as it is being printed. As little as 0.005 in. wear on the arbor causes a crease in the tube.

The phenolic arbor sleeves had to be changed about twice a week. The molybdenum disulfide-filled nylon arbor sleeves last about five times as long.

Cold Drawn Stainless Solves Tubing Problem

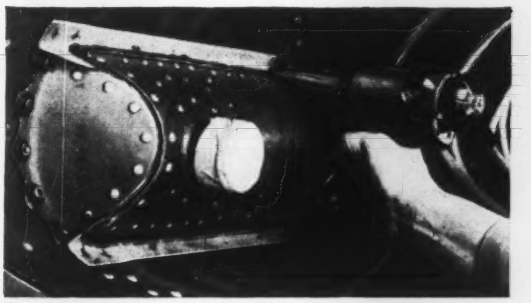
The use of cold drawn stainless steel tubing has solved two major problems in the design of a milking machine component.

The component, a milking machine claw, requires four steel nipples for attachment to teat cups (see photo). The nipples are rolled down on one end and press fitted into the body of the claw. The problems: 1) to obtain tubing that would be ductile enough for the rolling operation, yet

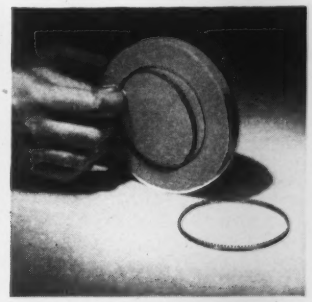
AWARDS COMPETITION—Entries for the 4th annual Awards Competition for the Best Use of Materials in Product Design are due Feb 1, 1960. See pp 107-110 for full details.

General Electric RTV silicone rubber

New liquid rubber cures without heat, useful from — 70 F to + 600 F, ideal for sealing, electrical insulation and flexible molds.

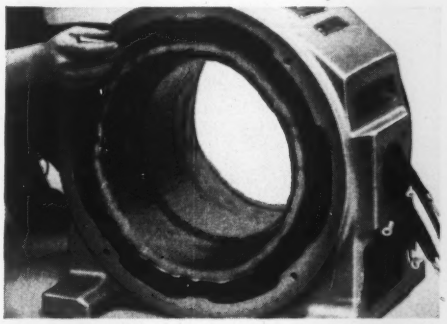


HEAT RESISTANT SEALING, such as shown on this Douglas DC-8 Jetliner, is made possible with RTV (room temperature vulcanizing) silicone rubber. RTV cures without application of heat; won't shrink (no solvents); forms no voids. It has excellent bond strength, plus resistance to high temperatures, moisture, weathering, ozone, aircraft fuels and solvents.

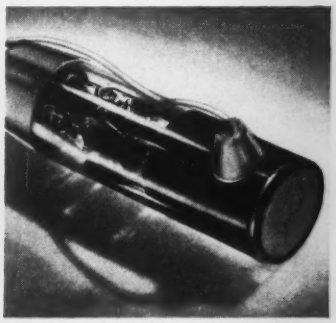


PRECISION MOLDING of prototype and engineering models and replacement parts is simplified and improved with RTV flexible mold material. G-E RTV's low shrinkage permits close tolerances and fine surface detail.

LOW-COST TOOLING with flexible RTV mold material offers added savings in time and expense. RTV's "built-in" release agent provides easy removal of this epoxy coil-winding form from mold. Total cost reduced 81%, delivery time 90%.



ENCAPSULATION OF STATOR WINDINGS, introduced by General Electric motor departments, extends service life of motors. RTV's resistance to moisture and other contaminants enables these dripproof motors to meet certain applications formerly requiring enclosed units.



POTTING OF AIRBORNE EQUIPMENT provides protection from high altitude arc-over and corona as well as vibration and moisture. RTV silicone rubber protects this cathode ray tube up to 70,000 feet.

RTV COIL IMPREGNATION enables this Hughes Aircraft Co. transformer to provide top performance at 250°. Unlike other insulations tried, G-E RTV compounds proved successful both for coil impregnation and full encapsulation.

For application data and samples of General Electric RTV silicone rubber write Section B1114, General Electric Company, Silicone Products Department, Waterford, New York

GENERAL ELECTRIC

For more information, turn to Reader Service card, circle No. 452

For almost every hardness testing requirement

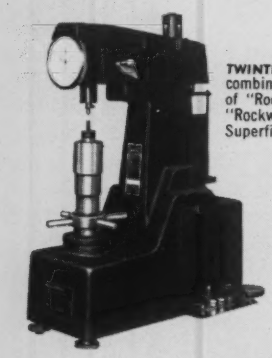
There's a Wilson "Rockwell" instrument to do the job

Wilson "Rockwell" Hardness Testers can help make your products better, stronger, longer lasting. They give reliable results on the production line, in laboratories, in tool rooms, and in inspection departments. They're as easy to use as a center punch, as durable as a machine tool, as sensitive and accurate as a precision balance. That's why Wilson "Rockwell" is recognized as the world's standard of hardness testing accuracy.

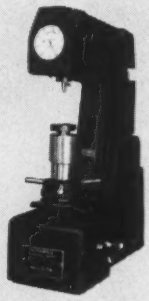
Write for Catalog RT-58. It gives complete details on the full line of Wilson hardness testing equipment.

Wilson "Brale" Diamond Penetrators give Perfect Readings

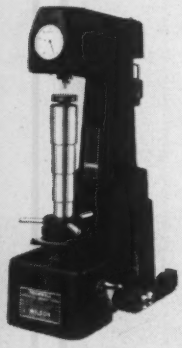
A perfect diamond penetrator is essential to accurate testing. Only flawless diamonds are used with Wilson "Brale" penetrators. Each diamond is cut to an exact shape. Microscopic inspection and a comparator check of each diamond—one by one—assure you of accurate hardness testing every time.



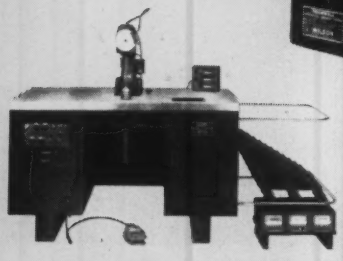
TWINTESTER combines functions of "Rockwell" and "Rockwell" Superficial Testers

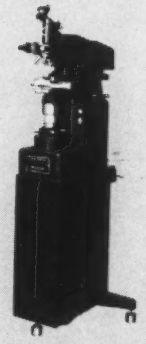


"ROCKWELL" HARDNESS TESTER for most hardness testing functions



"ROCKWELL" SUPERFICIAL TESTER for extremely shallow indentations





TUKON for precision micro and macro testing

AUTOMATIC—semi and fully automatic models for automatically classifying tested pieces at rates to 1,000 pieces per hour

WILSON "ROCKWELL" HARDNESS TESTERS

ACCO

Wilson Mechanical Instrument Division
American Chain & Cable Company, Inc.
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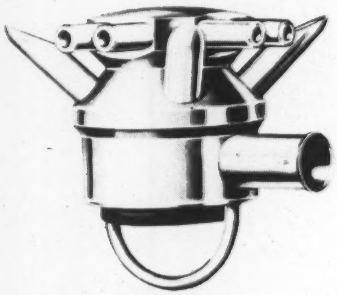


Milking machine claw *uses cold drawn stainless tubing.*

hard enough to resist collapsing during the press fit; and 2) to obtain a smooth finish on the inside of the tubing for easy cleaning.

Cold drawn 304 stainless tubing solved both problems. According to De Laval Co., Ltd., manufacturers of the milking machine component, the cold drawn stainless is less expensive than previously used seamless and does the job better. The tubing is made by Superior Tube Co.

Polyethylene Wheels Polish Metal Samples

Polyethylene polishing wheels are drastically reducing the amount of time necessary to prepare metal samples for metallurgical examination.

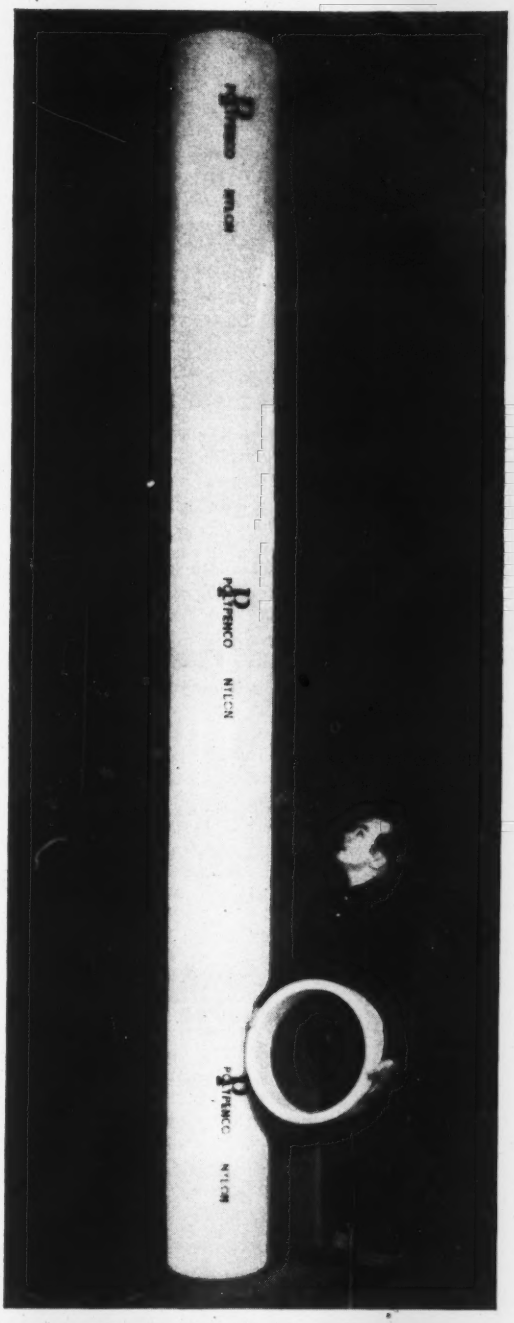
Replaces metal wheels

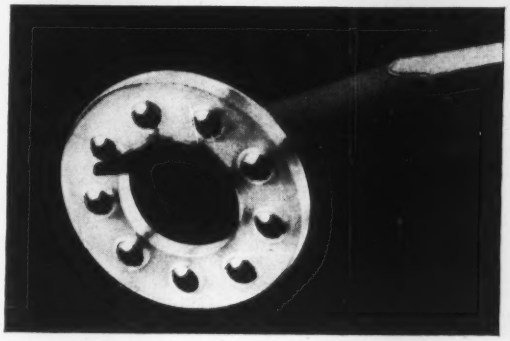
Polyethylene was selected to replace previously used metal wheels because it is resilient and resistant to the dilute acid wetting agent used in polishing. It can also be bonded to metals for use as a facing material. The accompanying photo shows a polyethylene-faced bronze wheel and a solid polyethylene wheel.

According to Pfaudler Co., the conventional polishing method usually required wax to protect the wheel against the acid. Excessive time was needed to prepare samples. For some of the refractory metals (such as tantalum and zirconium), polishing often took up to 12 hr and even then was not satisfactory.

Cuts polishing time

Typical of the polishing times





ANYWAY YOU LOOK AT IT...

Plaskon

NYLON 6 MEETS THE CHALLENGE

The Polymer Corporation needs a material that will meet the demands required for roller coverings in the processing of paper, textiles, artificial leathers and forming metal strips. *Result:* It uses Plaskon Nylon and makes the largest monolithic nylon shape ever manufactured.

The Rampe Manufacturing Company needs a material to mold retainers for steel ball bearings. Since these tiny bearings are slightly larger than the outside circumference of the assembly, the material must stretch, then contract during assembly. *Result:* It uses Plaskon Nylon and gets the best balance of toughness and flexibility possible!

In every industry today you'll find Plaskon Nylon Molded Parts performing a wide variety of difficult jobs. And because of Plaskon Nylon's superior properties—including outstanding abrasion and chemical resistance—it does these jobs better than metal . . . lasts longer too!

For information on how Plaskon Nylon can help you design or mold for profit, phone your Plaskon Representative, or write Plaskon Nylon Sales.

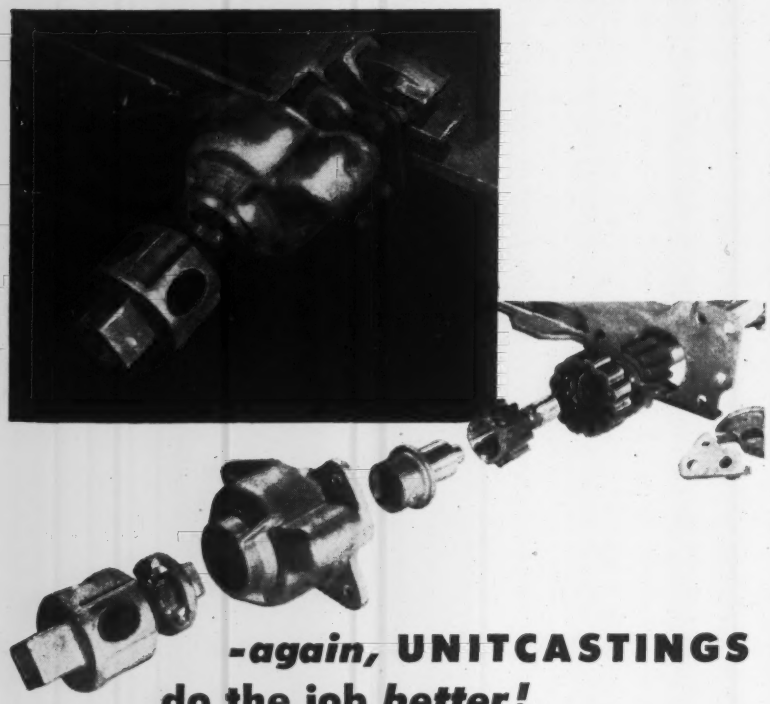
Allied Chemical

PLASTICS AND COAL CHEMICALS DIVISION

40 Rector Street, New York 6, N. Y.

For more information, turn to Reader Service card, circle No. 522

Progressive Foundry Engineering Develops Accurate Components..



-again, UNITCASTINGS do the job *better*!

Unitcast foundry technicians, working hand-in-hand with customer's engineers, match new processes and developments with new steel casting demands.

The close tolerance requirements of this new horizontal gate mechanism proved a challenge. Designed around a new hypo-cyclic gear to reduce operating effort 80%, finished costs had to remain competitive. Each component was delivered to finished size with only touch up grinding necessary before assembly, and a high quality, durable product was marketed with the benefit of cast steel.

Unitcast offers similar service to help you with close tolerance, cost reducing problems. Write or call today for complete information.

UNITCAST CORPORATION, Toledo 9, Ohio

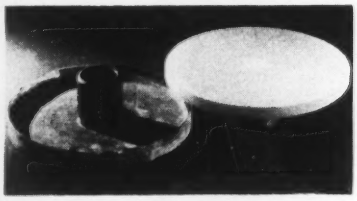
In Canada: CANADIAN-UNITCAST STEEL, LTD., Sherbrooke, Quebec

Unitcast

SPECIFICATION STEEL CASTINGS

For more information, turn to Reader Service card, circle No. 524

MATERIALS AT WORK



***Solid polyethylene wheel** (right) and metal wheel with polyethylene face (left) are more efficient than previously used metal wheels.*

achieved with the polyethylene-covered and solid polyethylene wheels: 30 min for tantalum, 5 min for zirconium. The polyethylene wheels can be used without modification for specimens of varying hardness.

Some of the other metals successfully polished with polyethylene wheels include: columbium, titanium, mild steel, stainless steel, copper, molybdenum, Hastelloy, glassed steel, carburized and decarburized steels, cast iron, ductile iron, and various coated metals.

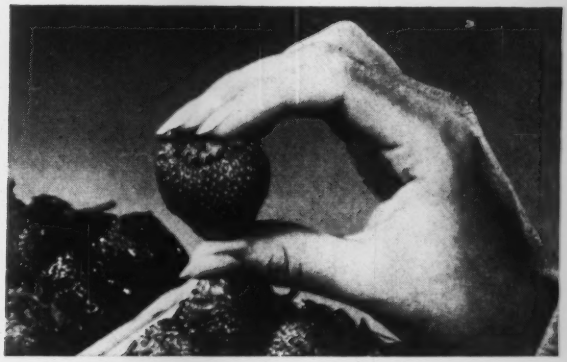
Pyroceram Mirrors in Airborne Telescopes

High power telescopes destined for outer space are now using mirrors made of Pyroceram. Four reasons: the glass-ceramic mirrors are said to provide higher resolving power despite extreme temperature changes; they retain their curvature regardless of environment; they are nonporous and unaffected by humidity and moisture; and they are extremely lightweight.

In order to maintain a fixed curvature, the mirrors are made as a sandwich consisting of two thin plates of Pyroceram held apart by short lengths of Pyroceram tubing (see accompanying photo). This construction also provides good rigidity and stability.

According to Corning Glass Works, the Pyroceram composition used in the mirror has a zero coefficient of expansion between –100 and 150 F. The material, like glass, can be ground and polished to high optical accuracy using standard techniques. In its glassy state Pyroceram is

1 This bottle molded of tough polyethylene carries:
(a) alkali *(b) acid for dry-shipped batteries*
(c) water



2 They're big and juicy when polyethylene film is used for:
(a) packaging *(b) mulching*
(c) hothouse glazing

Can you pass this test on Polyethylene Plastics?

(You'll discover more of their potential as design materials)

3 It's the new Atlantic cable, insulated with polyethylene for:
(a) dielectric strength *(b) flexibility*
(c) underwater identification

4 This muffin box is coated inside with polyethylene to:
(a) make it moisture-proof *(b) prevent grease staining*
(c) please the housewife

5 The familiar garbage can—a product polyethylene modernized:
(a) three ways *(b) four ways*
(c) five ways

ANSWERS... *to an increasing range of needs are found in BAKELITE polyethylene plastics.*

1. (b) Battery acid—unbreakable polyethylene bottles are inert to almost all chemicals.
2. (b) The mulch controls weed growth, keeps soil moist, berries off ground. Hothouse glazing and packaging could help too.
3. Check (a) and (b). It's water-proof, too, of course.
4. (a) and (b) are right—so (c) is a natural.
5. (c) Five important ways—non denting, light weight, integral color, less noise, and resistance to chemicals.

If you have questions—about designing with plastics for function, serviceability, economy and appearance—please ask us. We'll be glad to answer on the practical design and engineering uses of vinyls, epoxies, phenolics, styrenes, and polyethylenes. Just write or call any of our offices or write Dept. LV-02D, Union Carbide Plastics Company, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y. *In Canada:* Union Carbide Canada Limited, Toronto 7.

UNION CARBIDE

"Bakelite" and "Union Carbide" are registered trade marks of Union Carbide Corporation.

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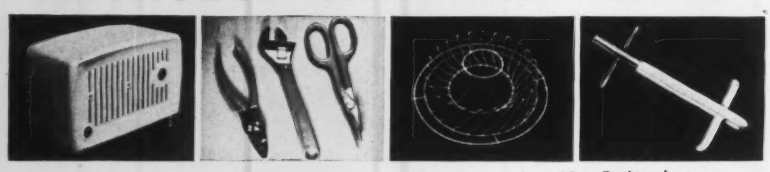
COATING PROBLEM ?

REYNOSOL* *SOLVED THESE PROBLEMS*



* Reg. Trademark

There's a special Reynosol formulation for your coating problem. And if it's steel you're coating you'll be interested in the extra benefits that only Reynosol can offer you.

What are they? Greater resistance to temperature . . . truest color control . . . greater tensile strength . . . lower total cost.

Reynosol coatings are as functional as they are decorative . . . as economical as they are reliable. Let Reynolds Chemical creative staff tackle your finishing problem — show you how Reynosol can finish your problem! They'll come up with exactly the answer — and the price — you've been hoping for. Write or phone today for full information.

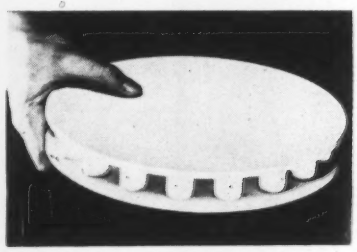
REYNOLDS CAN COAT IT — IF ANYONE CAN!

REYNOLDS CHEMICAL PRODUCTS COMPANY

Whitmore Lake, Michigan • Phone: Hickory 9-9361
DIVISION OF STUBNITZ GREENE CORP.

For more information, turn to Reader Service card, circle No. 512

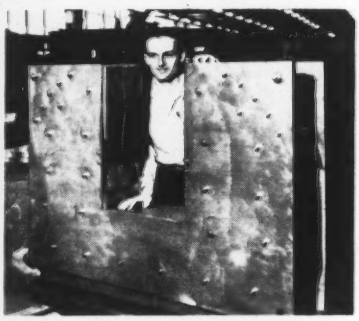
MATERIALS AT WORK



Sandwich construction *provides Pyroceram mirrors with rigidity, light weight, and resistance to temperature changes.*

transparent, and the entire mirror blank can be visually inspected for such defects as bubbles. Currently available mirrors are approximately 10 in. in dia and use plates ¼ in. thick.

The telescopes, used to observe the constellations without interference from the earth's atmosphere, are being sent aloft in balloons and missiles.

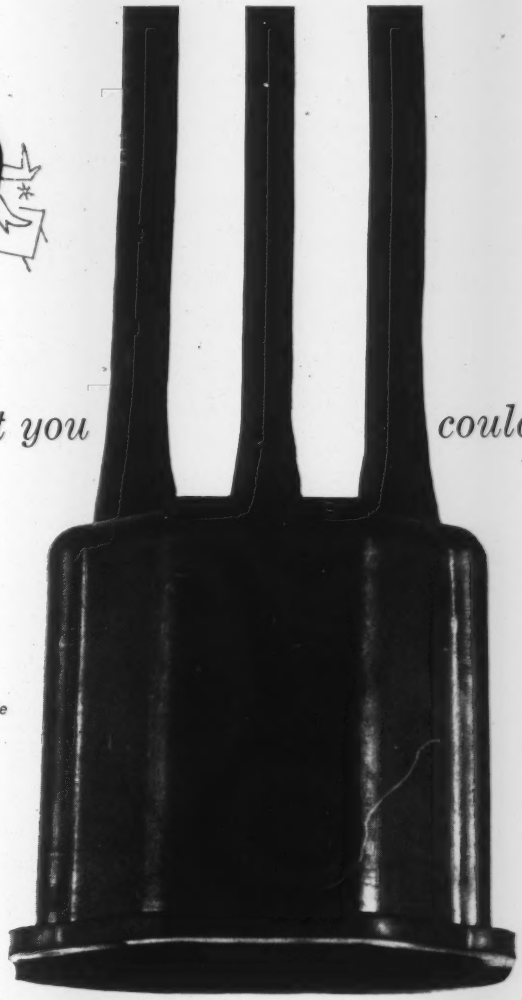


Largest magnet—Shown in the photo above is what is said to be the world's largest permanent magnet. Used to help pump liquid sodium in a breeder reactor, the magnet is made of Alnico V, weighs 1720 lb, and measures 52½ x 36 x 10 in. It has a gap length of 15½ in. and a gap volume of 1584 cu in. Density at the center of the gap is 1100 gausses. It took about 500,000 amp-turns to magnetize the unit. According to Arnold Engineering Co., a subsidiary of Allegheny Ludlum Steel Corp., a permanent magnet was selected in place of the customarily used electromagnet because it had to be completely surrounded by liquid metal.

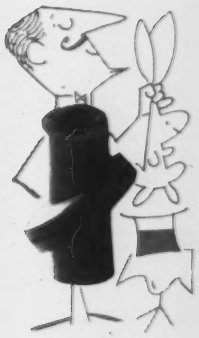
Cushion

Resist Weather

Ever think what you could do with **MOLDED RUBBER?**



Insulate



. . . and much more

Seal

Some of today's most significant product improvements are starting with a decision to try molded rubber. You have an amazing choice of physical properties when specifying custom rubber, and its ease of molding simplifies countless design problems. Roth research experts will tailor a special rubber exactly to your need . . . rubber that absorbs sound and vibration, provides flexibility, remains elastic in extremes of heat or cold, withstands abrasion, high voltage corona, solvents, oils, or chemicals. Roth production technicians guarantee flawless, precision molded products. Large or small runs are produced efficiently, economically, on schedule.

SEND FOR THIS NEW BOOKLET! It tells how Roth's unique engineering resources and flexible production facilities can give you invaluable help . . . shows why it pays to deal with people who *know* rubber. Send today for your copy of "New Design Opportunities through Roth Engineering-in-Rubber."

ROTH

RUBBER COMPANY

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Division of Vapor Heating Corporation

For more information, turn to Reader Service card, circle No. 368

THE VARIETIES OF HONEYCOMB

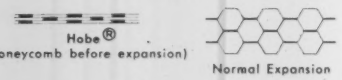
#6 CELL GEOMETRY The cell geometry, or configuration, of honeycomb is determined during manufacturing by the basic method of production. Two honeycomb production techniques are in use today: expansion and corrugation.

Expanded Honeycomb

The material for the honeycomb—pre-impregnated fiber glass cloth, aluminum alloy foil, paper, or other web materials—is fed from rolls into special high-precision machinery, where continuous stripes of structural adhesives are applied to the web. This web is then folded or cut into sheets and stacked in such a manner that the resulting bonded stack can be expanded to form hexagonal cells. Before expansion the stack is cured to set the node bond adhesive.

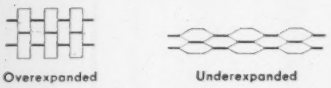
Figure 1 illustrates a stack, called HOBE® for HOneycomb Before Expansion, in a compressed condition and the resultant geometry under normal expansion.

Fig. 1



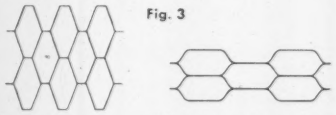
Expansion is normally stopped when the characteristic hexagonal-shaped cells are formed. By varying the degree of expansion from partial expansion to full over-expansion, virtually unlimited adjustment of the web area to volume relationship may be obtained. Figure 2 illustrates variations in cell geometry resulting from controlled expansion.

Fig. 2



By varying the width and location of the adhesive stripes, a number of other cell configurations are possible, such as those shown in Figure 3.

Fig. 3

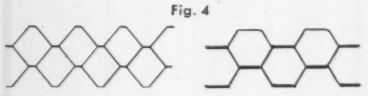


Corrugated Honeycomb

The material for corrugated honeycomb—aluminum alloy, stainless steel, titanium, and others—is pre-corrugated to the desired configuration. Precision equipment then joins the corrugated material at the node point with a resistance weld or an adhesive connection.

The corrugating technique is used principally for welded honeycomb products with the characteristic square-cell configuration shown in Figure 4. Corrugation is also adaptable to materials, foil gauges, or adhesive systems that do not lend themselves to the expansion process.

Fig. 4



MATERIALS The designer can call upon an extremely wide range of honeycomb materials to meet individual design problems.

Metallic Honeycombs

In standard production are aluminum alloys 3003 and 5052 and such stainless alloys as 17-7PH, PH15-7Mo, AM 350 and 355. Special production includes aluminum alloy 5056, a wide variety of stainless alloys, and exotic metals such as tantalum, molybdenum and titanium. Experimental work also continues on copper and carbon steel.

Non-Metallic Honeycombs

In standard production are non-impregnated Kraft paper and glass-fabric impregnated with phenolic resins, polyester resins and special heat-resistant phenolics. Special production includes phenolic impregnated Kraft paper and impregnated asbestos webs. In addition, experimental work continues on silicone, phenylsilane, rubber, and a number of sheet plastics.

Sizes and Shapes

Standard production cell sizes vary from 1/8" to 1½". Core materials have been produced with cell sizes as small as 1/32" and as large as 3". Cell depths up to 24" and piece sizes up to 48" x 96" are available in some materials. Available in flat panels of close tolerance thickness or block form, as well as finished carved and contoured core assemblies, honeycomb offers a broad variety of configurations, materials, sizes and shapes to open even broader areas of potential application.

Others in this series. Copies sent on request.

1. **Honeycomb Sandwich Panels**
2. **Honeycomb Sandwich Materials**
3. **Successful Honeycomb Sandwich Design**
4. **Honeycomb Design Characteristics**
5. **Honeycomb as an Energy Absorber**

* Trade Mark.

5419

INFORMATION REQUEST

Send to Hexcel Products Inc., Dept. 25
2332 Fourth Street, Berkeley 10, California.

NAME_____

TITLE_____

COMPANY_____

STREET_____

CITY_____ ZONE____ STATE_____

HEXCEL® PRODUCTS INC.

World leader in honeycomb

Executive Offices: 2332 Fourth Street, Berkeley 10, Calif.
Plants: Oakland and Berkeley, Calif.; Havre de Grace, Md.
Sales Offices: Long Island City, N.Y.; Fort Worth, Texas; Inglewood, Calif.

For more information, turn to Reader Service card, circle No. 505

Best Use of Materials

M/DE's 4th Annual Awards Competition for the Best Use of Materials in Product Design is now underway. The competition is designed to encourage sound, imaginative and progressive use of engineering materials in industrial and consumer products. Any new or redesigned product that was designed and produced in 1959 is eligible. For entry form and complete details on contest, see pp 107-110.

New Labs Study Materials

Four new laboratories will conduct research on engineering materials and processes.

▸ A new Physical Sciences Laboratory designed to perform research in molecular electronics, chemistry and physics has been put into operation by Melpar, Inc., a subsidiary of Westinghouse Air Brake Co.

The molecular electronics section will deal exclusively with research, development and fabrication of molecular circuitry systems. Through the application of "original concepts and techniques," Melpar expects to synthesize molecules with unique properties to provide "the new materials that will be required for the space age."

Work in the chemistry section will be concentrated on the chemical aspects of improved materials for electronic applications. The physics section will be responsible for the investigation of new solid state materials, development of high temperature measurement techniques, and research in plasma physics.

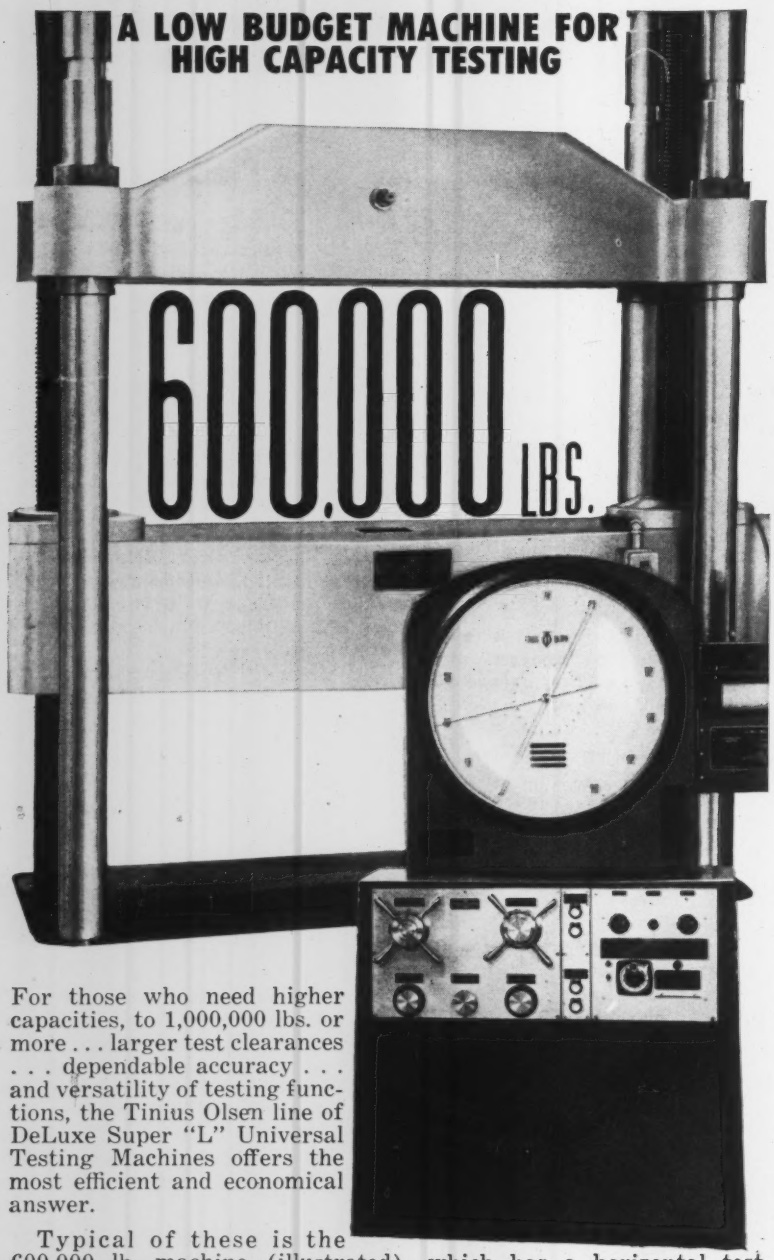
▸ A $3.5 million expansion of research facilities has been announced by Armco Steel Co. In addition to intensifying the company's efforts in the development of new steels and fabricating methods, the new laboratory will be used for two specific new projects: 1) extensive use of radioactive isotopes for nuclear studies; and 2) testing full-scale structural members of steel buildings.

▸ A new research and development center has been dedicated by U. S. Stoneware Co. The center, called Chamberlain Laboratories, will be concerned primarily with plastics, rubber, adhesives and protective coatings. Research goals will be the development of new products, improvement of manufacturing techniques, and development of standards.

▸ The final link in Union Carbide Corp.'s South Charleston, W.Va., Technical Center has recently been completed and projects can now be carried out from the basic research stage to final production. The scope of activity at the new Center ranges

Beryllium plant—Shown above is a section of Alsca Beryllium Machining Corp.'s new plant in Valley Stream, N. Y. The plant is set up to machine beryllium servo and gyroscope components to tolerances of 25 millionths of an inch. The plant has a specially-designed air conditioning and purification system, a high velocity exhaust system connected to each machine, and a medical director. Workers are required to wear disposable clothing.

A LOW BUDGET MACHINE FOR HIGH CAPACITY TESTING



For those who need higher capacities, to 1,000,000 lbs. or more . . . larger test clearances . . . dependable accuracy . . . and versatility of testing functions, the Tinius Olsen line of DeLuxe Super "L" Universal Testing Machines offers the most efficient and economical answer.

Typical of these is the 600,000 lb. machine (illustrated), which has a horizontal test clearance of 62 inches. Load is applied by the friction-free Olsen hydraulic system, and accurately indicated on the SelecTrange dial. Optional program controls can be set to automatically conduct a variety of cycling or variable loading tests. An electronic recorder together with choice of strain instrumentation produce precision stress-strain curves. Additional accessory controls, instrumentation and tools can be added as the need arises. In every detail, Tinius Olsen gives you the greatest return on your testing machine investment.

Write today for Bulletin 47-HC.

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TESTING MACHINE COMPANY
2010 EASTON ROAD • WILLOW GROVE, PA.
Testing and Balancing Machines

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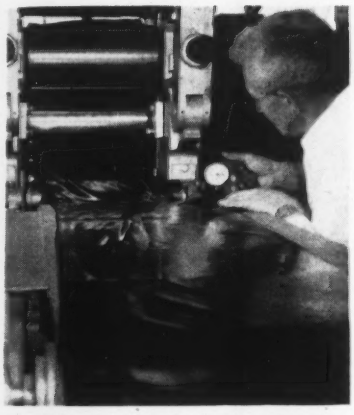
News OF INDUSTRY



***Small calender** is used in Chamberlain Laboratories to prepare samples of new rubber compounds for physical and chemical tests.*

from theoretical studies of molecular structure and basic research in chemical reaction mechanisms, to pilot-scale production of new products and the subsequent engineering and design of commercial production facilities.

Papers Requested on Powder Metallurgy

A request for papers has been made by the Program Committee of the 1960 International Conference on Powder Metallurgy.

The Conference, scheduled for June 13-15 at the Biltmore Hotel in New York City, will be devoted to 1) fundamentals and theory; 2) technology and methods; and 3) alloys, materials and applications. Purpose of the Conference will be to evaluate the present status of powder metallurgy and its role in today's advanced technology. Papers are invited on any of the three areas listed above.

According to the joint sponsors of the conference—Metal Powder

SOURCES of most engineering materials can be found in the third edition of M/DE's *Materials Selector* reference issue, published in October. Properties of all materials are also given.

PRODUCT-DESIGN BRIEFS FROM DUREZ

- **Fire-safe umbrella roof**
- **Plastic for toughest electrical jobs**
- **Where to get ideas**

Speaking of Stability

This is one piece of a small roomful of high-class electronic hardware.

The hardware represents man's latest and most sophisticated effort to cram into 123 square feet of floor space the means of discovering in one day which of 15,000 small semiconductors will work in a given set of circumstances, and which ones won't.

STROMBERG-CARLSON

This piece carries the semiconductor through the test gantlet. Around and around it goes, over six electrical-test hurdles, through an oven at a blistering 200°C, and back again for another trip.

Few materials have what it takes to survive this merry-go-round with virtually no change in size, shape, strength, toughness, and insulation values. Here you see one that does—a Durez diallyl phthalate molding compound filled with glass roving.

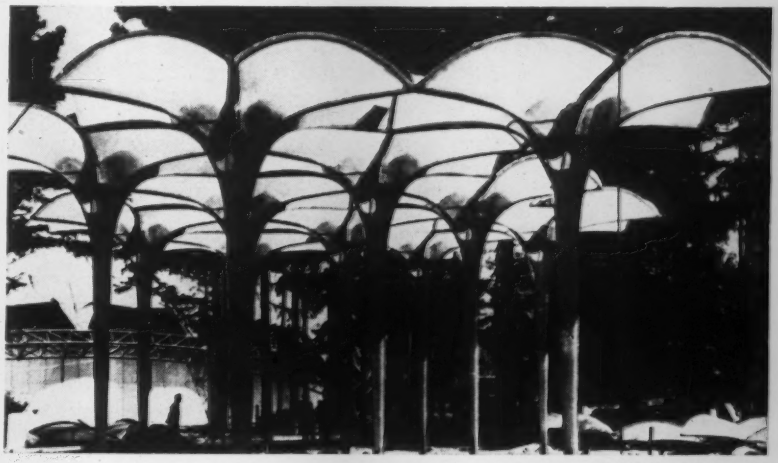
This is just one of the family. As a class, Durez diallyl phthalate compounds offer unsurpassed freedom from cold flow and creep, high reproducible arc resistance, a chilly indifference to moisture.

You get more information on them by talking over the intended application with your molder. He can describe them far more glowingly than do our data sheets, which we'll gladly send you.

Symbol

When promoters of the American National Exhibition in Moscow displayed a cross-section of America in old Sokolniki Park under flaring umbrellas of glass fiber and Hetron,® they built even better than they knew.

For the tapering 16-foot columns arching into 15,000 square feet of fire-resistant roof, architect George Nelson used our Hetron polyester. One of the reasons: Hetron does not support combustion; it requires no additives, as do other polyesters, to make it resist fire.



OWENS-CORNING FIBERGLAS CORP.

Another reason: strength. Structural engineers learned that winds in Moscow sometimes reach 60 mph. So they tested five of the lily-like umbrellas at Mitchell Field, N. Y., by blasting them with 60-plus-mph gusts from the twin propellers of an Air Force bomber.

The payoff: a coup for the U. S. when a sudden Moscow storm caused aluminum arches to buckle badly in the sparsely attended Soviet exhibition next door. In the jam-packed U. S. showcase, Hetron stood fast.

Idea Starter

That's the virtue of our modest little bimonthly bulletin, *Durez Plastics News*. It starts ideas.

It discusses products, from closures to computers, from plastic portholes to potentiometers. It shows you how Durez plastics are used.

Though its scope is the whole world of products and product design, you can read it through in 10 minutes. Thousands of people tell us it helps them keep up to date, in an age when keeping up to date can be a full-time job.

We'd like to send *Durez Plastics News* to you. May we? If you'd like to receive it regularly, just check the coupon.

For more information on Durez materials and services mentioned above, check here:

- ☐ Data file on Hetron, including list of fabricators
- ☐ Diallyl phthalate molding compounds (data sheets)
- ☐ *Durez Plastics News* (bimonthly bulletin)

Clip and mail to us with your name, title, company address. (*When requesting samples, please use business letterhead.*)

DUREZ PLASTICS DIVISION

1412 WALCK ROAD, NORTH TONAWANDA, N. Y.

HOOKER CHEMICAL CORPORATION

HOOKER CHEMICALS PLASTICS

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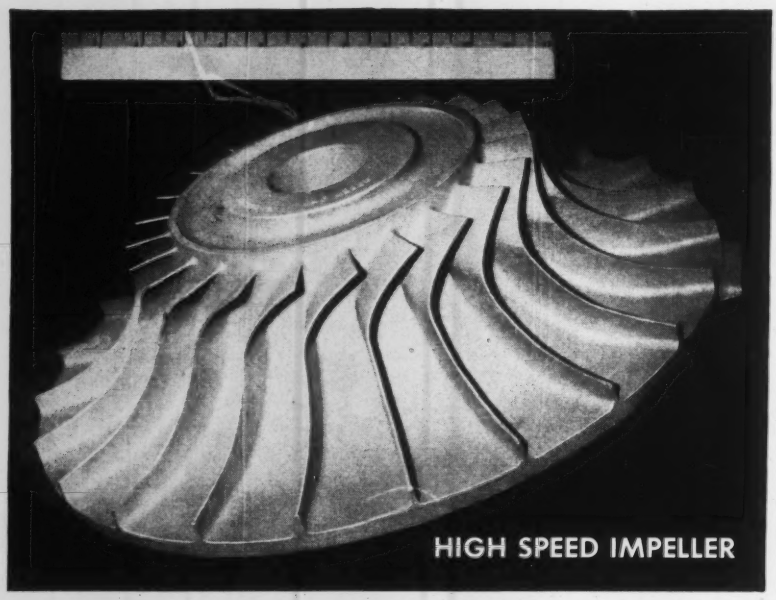
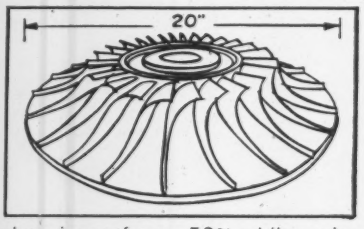


CONVERSION TO STEEL CASTINGS EFFECTED SAVINGS OF OVER 50%!

HERE'S HOW ONE MANUFACTURER SAVED OVER 50% IN PRODUCTION COSTS BY CONVERTING TO LEBANON STEEL FOUNDRY'S CERAMICAST PROCESS . . .

This Third Stage High-Speed Impeller was produced for the Carrier Corporation, Syracuse, New York. The Impeller was originally designed and manufactured as a forging, with the curved blades welded in place. Mechanical properties were good, but production costs extremely high.



Lebanon's Foundry Engineering Service solved the problem by producing the Impeller as a one piece steel casting in a unique combination of the CERAMICAST Process and other precision methods. It is now cast of Circle L 205, Grade A1-ASTM No. A-148-55, Grade 105-85. The use of a Lebanon Steel Casting has effected savings of over 50% while maintaining equal mechanical properties. During tests the Impeller attains a speed of over 12,500 rpm—held for 30 minutes.

Steel component parts now being machined, forged or fabricated can often be CAST BY LEBANON at considerable cost savings, with improved design and physical properties. Lebanon's Foundry Engineering Service will review your requirements and make specific recommendations if a conversion to steel castings can achieve lower costs for you.

DETAILED CASE HISTORIES of this and other cost saving applications, in a wide range of industries, will be sent on request. Write today for your copy.

LEBANON STEEL FOUNDRY

CARBON, LOW ALLOY AND STAINLESS STEEL CASTINGS
148 LEHMAN STREET LEBANON, PENNA.

For more information, turn to Reader Service card, circle No. 513

Industries Federation and the Powder Metallurgy Committee of the Metallurgical Society of AIME—contributors should submit a 200-word abstract to the Program Committee's chairman, Dr. C. G. Goetzel, New York University, Dept. of Engineering, University Heights, New York 53.

Glass-Polyester Panels Undergo Fire Tests

Results of fire tests on standard glass fiber-reinforced polyester corrugated structural panels for use as rooflighting materials have been released by the Fiberglass Reinforced Panel Council of the Society of the Plastics Industry, Inc.

The tests were conducted on a 20 x 100-ft building whose roof consisted of standard reinforced polyester panels alternated with corrugated galvanized iron panels. As a result of the tests, the following recommendations were made:

1. Standard reinforced polyester panels may be used without area limitations in buildings equipped with automatic sprinklers.
2. In buildings not equipped with automatic sprinklers, total amount of reinforced plastics panels used should not exceed 25% of roof area; panels should be separated on all sides from other reinforced plastics panels by noncombustible materials equal to three times the reinforced plastics panel width; and total area of any single area of standard reinforced plastics panels should not exceed 400 sq ft.
3. Fastened panels should resist a gross wind uplift force of either 30 psi or 45 psf.

Engineers

S. P. Kaidanovsky, consulting engineer, has been given the Standards Engineers Society–American Society for Testing Materials award for outstanding contributions to the literature on standards.

Gwilym A. Price, chairman of the board, Westinghouse Electric Corp., has been awarded the John Fritz Medal, an annual award of achieve-

another special from ACIPCO

ERIE FOUNDRY CO. PICKS ACIPCO TUBING FOR CARBON EXTRUSION PRESS PLUNGER

You're looking at a new 2000-ton horizontal carbon extrusion press manufactured by the Erie Foundry Company's hydraulic press division. Designed for the production of carbon electrodes, the press features ACIPCO centrifugally spun steel tubing in its main ram plunger.

Custom-spun by ACIPCO, the plunger is 30.50" O.D. with 125 micro-inch finish and 2-5/8" wall thickness. Main ram is 42" in diameter and has a 105" stroke. Produced with heads statically cast at ACIPCO, the plunger's overall length is 144".

Fabricated applications such as this are a specialty with ACIPCO. Completely equipped to solve a wide variety of tubing problems, ACIPCO can serve your needs more efficiently and economically because all its facilities are under one roof. For expert consultation on centrifugally spun tube applications in your field . . . call on ACIPCO.

VERSATILE ACIPCO CENTRIFUGALLY SPUN STEEL TUBES

SIZE RANGE: Lengths up to 40" to meet modern machinery requirements have been produced. OD's from 2.25" to 50"; wall thicknesses from .25 to 4".

ANALYSES: All alloy grades in steel and cast iron, including heat and corrosion resistant stainless steel, plain carbon steel and special non-standard analyses.

FURNISHED: As cast, rough machined, or finished machined, including honing. Complete welding and machine shop facilities for fabrication.

SPECIAL PRODUCTS DIVISION
AMERICAN
CAST IRON PIPE CO.
BIRMINGHAM 2, ALABAMA

ACIPCO

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Well established in special nuclear applications, BERYLLIUM METAL is now being used and tested for structural components in other industries.

High strength to weight ratio • good high temperature properties • high modulus • excellent heat sink characteristics make this light metal attractive for current and future design.

Availability has improved—in quantity and mill forms—fabrication sources are increasing rapidly.

Let us send our latest literature—technical sales service available. Keep abreast of latest developments with the growing use of BERYLLIUM through . . .

BERYLCO® **THE BERYLLIUM CORPORATION**
READING, PENNSYLVANIA

Write to SALES ENGINEERING—BERYLLIUM METAL DEPT. for latest literature.

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News OF INDUSTRY

ment given by the following four national engineering societies: ASCE, AIME, ASME and AIEE.

Richard W. Black has been named government projects engineer, Vitro Engineering Co., a division of Vitro Corp. of America.

Stanley R. Curtis is now project engineer, Tranter Mfg., Inc.

Geoffrey Paget has been named chief metallurgist, Shaw Process Development Corp., a subsidiary of British Industries Corp.

Forest B. Griffin has been appointed production manager, Metal Hydrides Inc.

Gerald Lewis has been named director of product engineering, Cooper Alloy Corp.

Donald H. Mitchell has been appointed manager of J. I. Case Co.'s newly-formed Industrial Products Div.

Edwin B. Watson has been named chief engineer, Diesel Dept., Scintilla Div., Bendix Aviation Corp.

Richard C. Henshaw is now manager of operations, Lord Mfg. Co.

W. P. Dunlap has been appointed manager of Mobay Chemical Co.'s New Martinsville, W. Va., plant.

Albert Wiebe is now chief, research and development branch, U. S. Small Business Administration, New York City.

Dr. Gregory D. Hedden has been named technical director, research laboratory, Trionics Corp., Madison, Wis.

Leon C. Koenig has been appointed vice president of manufacturing, Lindberg Engineering Co.

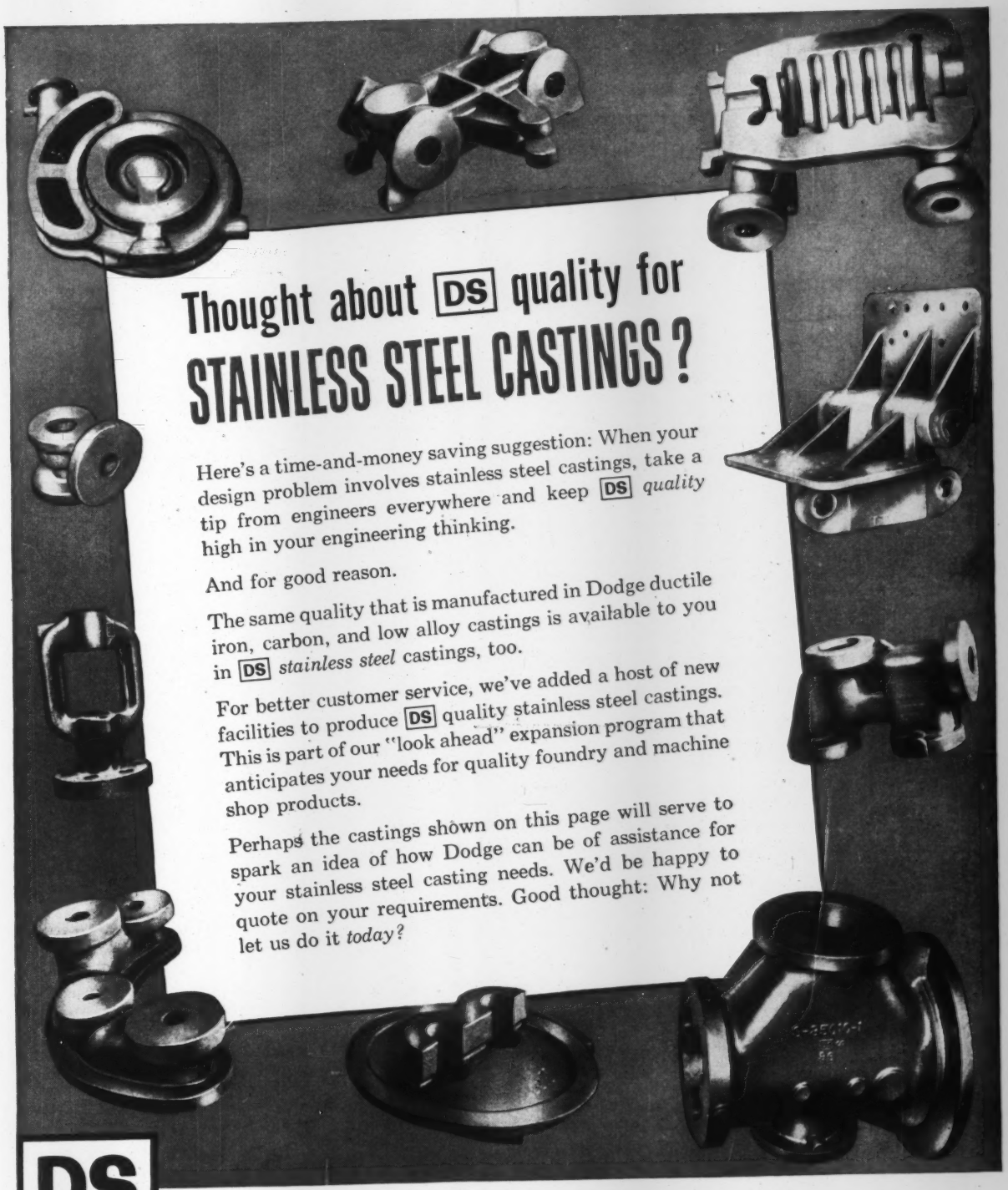
Dr. Wendell P. Metzner has been appointed administrative director, Research Center, Organic Chemicals Div., Monsanto Chemical Co.

Robert E. Peter is now chief engineer, Tempo Instrument Inc.

Dr. Finn J. Larsen has been named to the newly created position of vice president in charge of research, Minneapolis-Honeywell Regulator Co.

Edward J. Sydor has been appointed chief engineer, Cycleweld Chemical Products Div., Chrysler Corp.

Arthur F. Bernthal is now managing director of Bundy Tubing Co.'s Re-



Thought about DS quality for STAINLESS STEEL CASTINGS?

Here's a time-and-money saving suggestion: When your design problem involves stainless steel castings, take a tip from engineers everywhere and keep DS *quality* high in your engineering thinking.

And for good reason.

The same quality that is manufactured in Dodge ductile iron, carbon, and low alloy castings is available to you in DS *stainless steel* castings, too.

For better customer service, we've added a host of new facilities to produce DS quality stainless steel castings. This is part of our "look ahead" expansion program that anticipates your needs for quality foundry and machine shop products.

Perhaps the castings shown on this page will serve to spark an idea of how Dodge can be of assistance for your stainless steel casting needs. We'd be happy to quote on your requirements. Good thought: Why not let us do it *today*?

DS

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THE MOST IMPORTANT PIECE IN A STEEL CASTING IS QUALITY

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Wing Nuts
Cap Nuts
Thumb Nuts

now! **WASHER BASE WING NUTS** from **GRC STOCK**

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MOLDED NYLON
Screws
Hex Nuts
Washers
Screw Insulators

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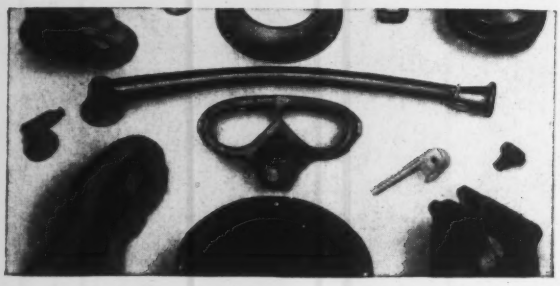
ACUSHNET SPECIALIZES IN PRECISION RUBBER MOLDING



Complex or conventional in design, your rubber part can be *precision-molded* by Acushnet with properties to meet the most exacting specifications. Our entire facilities and specialized engineering skills are concentrated on the development and production of precision-molded rubber parts – to order.

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Send for your copy of the Acushnet "Rubber Data Handbook" a comprehensive source of information widely used in industry as an authoritative reference for molded rubber parts.

Address correspondence to 750 Belleville Ave., New Bedford, Mass.

search and Development Laboratories.

Leonard G. Walker has been named manager, Communication and Control Systems Dept., Equipment and Systems Div., Raytheon Co.

A. Lee Graham has been named vice president in charge of operations, American Forge & Mfg. Co.

Charles J. Schmidt has been named director, Radiation Laboratory, Research and Development Div., W. L. Maxson Corp.

Companies

James F. Lincoln Arc Welding Foundation has announced its annual Engineering Undergraduate Competition in mechanical and structural design. This year's contest closes July 1, 1960.

Miniature Precision Bearings, Inc., has announced its 1959 Miniaturization Awards Competition. Information on the contest, which closes Jan 20, 1960, may be obtained by writing to: Miniaturization Awards Committee, Box 604, Precision Park, Keene, N. H.

AiResearch Mfg. Div., Garrett Corp., has begun construction of a $2.6 million building in Torrance, Calif.

Raybestos-Manhattan, Inc. has begun expansion of its Wabash Div. plant in Crawfordsville, Ind.

Consolidated Vacuum Corp. is the new name for Rochester Div., Consolidated Electrodynamics Corp.

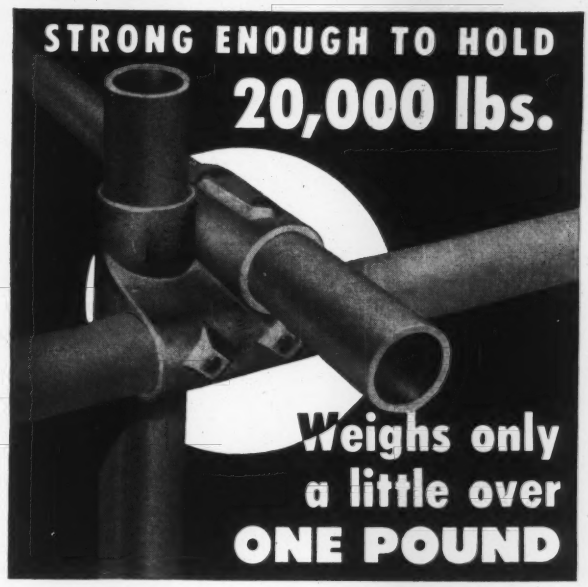
Plastic Age Mfg. Co. is a new company formed by the merger of **Plastic Age Aircraft Corp.** and **Plastic Age Reinforced Products.** The company is located in Mint Canyon, Calif.

Robinson Technical Products Inc., Teterboro, N. J., has acquired **High Vacuum Equipment Corp.**, Hingham, Mass.

Vulcanium Corp. has opened its new factory at 3080 Skokie Valley Hwy., Highland Park, Ill.

Aluminum Co. of America plans to build a new multi-million-dollar research and development center in Merwin, Pa.

Precision Cold Forged Products Co., Detroit 38, Mich., is a new company



Good Design and FRONTIER 40-E® aluminum alloy makes it SAFE and SURE

This is a Hosking Slip-on fitting combining great strength and lightness, one of a complete line of fittings made of Frontier 40-E. This high strength aluminum alloy imparts a yield strength to Hosking fittings 39% higher than ordinary aluminum fittings (25-35,000 psi). Hosking can be sure that the designed strength will be realized because Frontier 40-E always reaches its top strength by natural aging, developing in the casting to the full specified strength or greater. The exceptional impact strength of Frontier 40-E also adds to the toughness and service of these fittings.

Hosking fittings are SAFE where safety counts — in scaffolding. Pipe and tube slip-on fittings are also used to build racks, fences, awning frames and wherever pipe or tube must be connected. They are available from John H. Hosking Co., Cincinnati 23, Ohio.

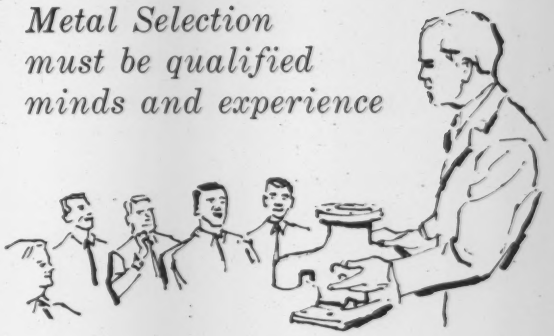
For application data on Frontier 40-E Alloy, write or call:

FRONTIER BRONZE CORP.

4874 PACKARD ROAD NIAGARA FALLS, NEW YORK

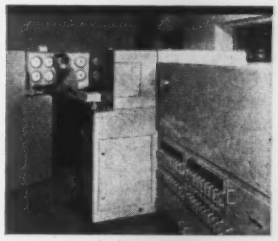
For more information, turn to Reader Service card, circle No. 376

Back of Metal Selection must be qualified minds and experience



WAUKESHA FOUNDRY

— experienced in corrosion-resistant castings since 1914, is qualified to help!



Spectrometer checks each heat

3 complete foundries in Waukesha

The Watertown (Wis.) plant

WAUKESHA FOUNDRY — established in 1914 — has always specialized in stainless steel and corrosion-resistant castings. While it is the largest foundry working exclusively in these difficult metals, yet WAUKESHA'S versatility and facilities are such that one casting or a long production run can be handled with high efficiency.

And WAUKESHA'S laboratories are equipped and staffed — not only for strict production control but for excellent research on your metallurgical problems.

WAUKESHA'S service goes from the blueprint to the finished casting!

METALS OFFERED

STAINLESS STEEL. 5 types. Martensitic for maximum hardness . . . Ferritic for use where exposed to atmosphere, water or for scale resistance . . . Austenitic (including the 18-8 alloys) which can be welded without subsequent heat treatment.

In addition there is WAUKESHA METAL — a copper base, high nickel content, solid, white, highly corrosion resistant alloy. 12 WAUKESHA METAL formulations are available. Please write giving your requirements and we will make specific recommendations.

Also copper, brass, aluminum, pure nickel, Inconel, Monel, Everdur and many others.

Waukesha FOUNDRY COMPANY

5904 Lincoln Avenue • Waukesha, Wisconsin

8040

For more information, turn to Reader Service card, circle No. 460

No. 8 of a series

Eastman 910 Adhesive solves another design bottleneck

Directly measuring dimensional changes in structural members under stress, strain gages provide aircraft designers with performance data at almost any point in the airframe during flight testing. As many as 8,000 gages have been used during the flight testing program of a single aircraft.

Because of its rapid setting characteristics and its ability to adhere to virtually any material, Eastman 910 Adhesive has become the preferred adhesive for attaching strain gages.

Conventional adhesives require up to 24 hours curing time before reliable readings can be taken. *Use of Eastman 910 Adhesive can reduce this waiting period to less than 5 minutes.*

Eastman 910 Adhesive is making possible faster, more economical assembly-line operations and new design approaches for many products. It is ideal where extreme speed of setting is important, or where design requirements involve joining small surfaces, complex mechanical fasteners or heat-sensitive elements.

Eastman 910 Adhesive is simple to use. No mixing, heat or pressure is required. Upon spreading into a thin film between two surfaces, setting begins immediately. With most materials, strong bonds are made in minutes.

What production or design problem can this unique adhesive solve for you?

Bonds Almost Instantly ...Without Heat, Pressure or Catalyst

For a trial quantity (⅓-oz.) send five dollars to Armstrong Cork Co., Industrial Adhesives Div., 9112 Dunbar Street, Lancaster, Pa., or to Eastman Chemical Products, Inc., Chemicals Div., Dept. E-12, Kingsport, Tenn. (Not for drug use)

For more information, circle No. 463

News OF INDUSTRY

formed to serve automotive and allied manufacturing companies.

Bendix Aviation Corp. has broken ground for a new 72,000-sq ft semiconductor products plant in Holmdel, N. J.

Harvey-Wells Electronics, Inc. has moved its Research and Development Div. to a new building in Industrial Park, East Natick, Mass.

Tenney Engineering, Inc. has purchased **Kirsch Co.'s** Copper & Aluminum Coil Div.

Weyerhaeuser Co. is the new name for **Weyerhaeuser Timber Co.**, Tacoma, Wash.

Dow Chemical Co. has formed a new Long Range Plastics Application Laboratory, with Douglas S. Chisholm as head.

Kaiser Aluminum & Chemical Corp.'s Products Div. has established a new Product Planning & Development Dept.

Electric Auto-Lite Co. has purchased **C & D Batteries, Inc.**, Conshohocken, Pa.

Thompson Ramo Wooldridge Inc.'s Tapco Group has broken ground for a new plant in Anaheim, Calif.

Robertshaw-Fulton Controls Co.'s Eastern Research Center has moved to a new building on the Schuylkill Expressway, King of Prussia, Pa.

Precision Disc Grinding of Calif., Inc., is a new West Coast Div. of Precision Disc Grinding Corp.

Engineering Service, Inc. of America has moved to new quarters at 21556 Telegraph Rd., Detroit 41, Mich.

Aeroplastics Corp. has moved to new quarters in Venice, Calif.

Airline Welding & Engineering has moved to a new 38,000-sq ft plant at 15909 S. San Pedro St., Gardena, Calif.

Radio Corp. of America plans to construct a 100,000-sq ft addition to its Moorestown, N. J., plant.

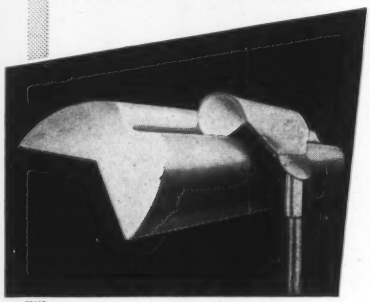
Arnoux Corp. has acquired **Automation Electronics, Inc.,** 1500 W. Verdugo Ave., Burbank, Calif.

Solar Aircraft Co. will build a new 62,000-sq ft engineering and research building in San Diego, Calif.

Speer Carbon Co. has purchased **Onondaga Pottery Co.'s** Electronics Div.

Ford Motor Co. will open a new office in Boston, Mass. for advanced re-

Another product made better with MOLDED FIBER GLASS



It's a street light housing

for the new Westinghouse Mainstreeter Fluorescent Luminare

. . . weather resistant, won't rust, rot or corrode

. . . tough, resistant to hail, wind, mechanical damage

. . . lightweight, rigid, easy to mount

. . . molded-in color requires no painting

. . . smooth, modern, streamlined — custom molded to Westinghouse designs

. . . and economical!

Do you have a product which can be made *better*, at less cost, with MOLDED FIBER GLASS? Write today. Free literature available.

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Industrial Glass Fabrics

are specified for the new Hudson TUF-LIFE fan blades made by Hudson Engineering Corporation to provide tough, lightweight and safe fan blades for use in oil, gas and chemical plant process cooling and ventilation.

For information about how Trevarno Resin Pre-Impregnated Glass Fabric can help you solve your problems, write or call District Office nearest you:

Los Angeles:
635 S. Kenmore Street — DU 8-5260
Dallas, Texas:
4924 Greenville Ave. — EM 8-7871
In the Midwest:
114 N. Main St., South Bend, Ind.
CE 3-1821 . . . or write directly to
Coast Manufacturing & Supply Co.
P. O. Box 71, Livermore, California

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GLASS FABRICS

TUF-LIFE fan blades are made of Trevarno Glass Fabrics, strongly bonded and covered with synthetic resin. Their lightweight and tough fiber structure protect personnel and equipment from hazards of fan accidents.

TUF-LIFE fan blades are quiet, efficient, corrosion proof, easy to install and adjust, aerodynamically designed.

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for abrasive resistant applications

There is literally no end to the ways you can use Frenchtown alumina ceramics in abrasive resistant applications. For example:

Nozzles: Sand, steam slurry, recoiless rifle, rocket, and particle classifiers.

Guides: Thread, wire, rope.

Dies: Ceramic extrusion, plastic injection molding, tablet pressing.

Pumps: Plungers, impellers, case plates, valves.

Gages: Plug, wear plates on measuring equipment.

Our newly designed and installed equipment permits us to offer a wide variety of shapes, sizes and configurations, in any quantities and at low cost. Write for complete details and descriptive literature.

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FRENCHTOWN, NEW JERSEY

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CASTING TO STAMPING saves 55%

Originally this grey iron casting required expensive milling and drilling operations. In 350 lots the piece price was $1.18 plus pattern, milling fixture and drill jig charges.

Converting to a stamping formed from 12 gage sheet steel cut the piece price to 53c *including tooling.* The present stamping is lighter, stronger, better duplicated and improved over-all.

Bulletin F-185 explains this highly efficient, specialized technique for cutting the work load and costs of metal fabricators. Write for it today.

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Manufacturing Company
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Production and Repair Plating

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Enables You to (1) Precision-plate selected areas economically — without disassembling components; (2) Deposit metals rapidly where conventional electro-plating is impossible or difficult. Mobile equipment takes the process to the job.

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Hundreds of different patterns—aluminum, stainless steel, carbon steel, copper, brass, monel—anodized, plated or painted any color—fabricated to your specifications.

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News OF INDUSTRY

search and development work in space sciences, astrodynamics and range instrumentation.

Norton International Inc. is the new corporate name of **Norton Behr-Manning Overseas Inc.**

Accurate Specialties Co., Inc., Woodside, N. Y., has acquired 80% of **Duramic Products, Inc.'s** common stock.

Crane Co. has purchased **Chapman Valve Mfg. Co.,** Indian Orchard, Mass.

Monsanto Chemical Co. has acquired all outstanding stock of **Nitro Industrial Corp.**

Societies

Gray Iron Founders' Society, Inc. has elected the following officers: president—Albert M. Nutter, E. L. LeBaron Foundry Co.; vice president—J. E. Quest, Shakopee Foundry Co.; secretary—R. W. Wilder, Elkhart Foundry & Machine Co.; and treasurer—Cecil R. Garland, W. O. Larson Foundry Co.

Pressed Metal Institute has elected the following officers: president—F. F. Rimmler, Volkert Stampings, Inc.; vice presidents—M. A. Sherwood, Grand Haven Stamped Products Co.; and W. J. Primrose, Jr., Dickey-Grabler Co.; secretary-treasurer—Melvin Lorentz, HPL Mfg. Co.; and honorary secretary-treasurer — W. Bryant Gemmill, American Stamping Co.

Powder Metallurgy Parts Mfrs. Assn. has elected the following officers: president—Carl J. Demrick, Amplex Div., Chrysler Corp.; vice president—Smith Bolton, U. S. Graphite Co.; and treasurer—G. G. Fellows, American Powdered Metals, Inc. Marshall E. Jetty, Brockway Pressed Metals, Inc., was elected to the board of directors.

Aluminum Smelters Research Institute has elected the following officers: president—Herman J. Galamba, Sonken-Galamba Corp.; vice president—John P. Brull, North American Smelting Co.; secretary—Carl H. Burton; and treasurer—D. H. Warner, Aluminum & Magnesium, Inc.

Porcelain Enamel Institute announces the following officers: president—Robert N. Smith, Temco, Inc.; vice

Stainless RIGID-tex Metal Special pattern produced exclusively for Mercury Motors.

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combines GOOD DESIGN and RIGID-tex® METAL

You can always spot a Mercury motor by its gleaming, stainless steel RIGID-tex Metal cowling. A sound absorbing blanket inside the cowling reduces powerhead noises. The special pattern which is the engine manufacturer's own design is produced for them *exclusively*. It adds rigidity without adding weight. It withstands ordinary knocks and abuse without denting and its bright surface will always remain beautiful.

RIGID-tex Metal is available in all metals . . . all colors. There are more than 45 standard patterns from which to choose. Phone or write for complete information.

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PLAN *with--*
SAVE *with--*
RELY *on--*
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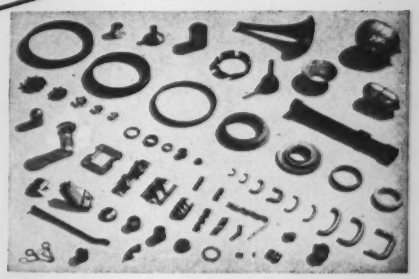

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Intricate, Light & Medium

Parts shown range from ½" to 8" in size.

METAL STAMPINGS

Exacting tolerances, strength and surface finishes of parts made of copper, brass, aluminum, Monel, stainless, high carbon and alloy steels.
Operating 50 pieces of production equipment to blank, pierce, form, draw, swedge, coin, drill, tap, heat treat, anneal, silver braze, test and assemble. Complete tool room facilities for producing all dies. Modern inspection equipment assures quality control.
Accurate quotations furnished with breakdown as to tool cost and piece price. Our engineering staff is available for consultation, without cost or obligation to you.

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ESTABLISHED 1924

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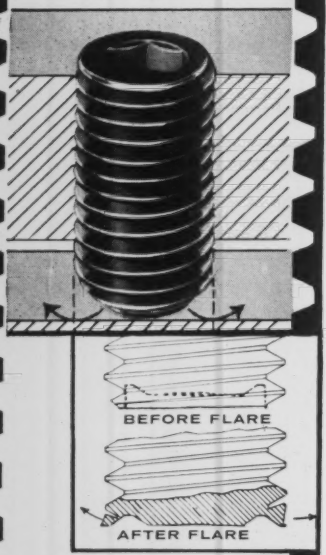
FLARE-LOK
SET SCREW WILL NOT SHAKE LOOSE!



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News OF INDUSTRY

presidents—J. F. Corkill, U. S. Borax & Chemical Corp.; H. A. Ringelberg, Challenge Stamping & Porcelain Co.; Herbert Turk, Sr., Pemco Corp.; and J. C. Winget, Armco Steel Corp.; secretary and managing director—John C. Oliver; and treasurer—P. B. McBride, Porcelain Metals Corp.

Meetings

TREATMENTS AND FINISHES FOR AEROSPACE MATERIALS CONFERENCE, American Electroplaters' Society and Southwest Society of Aircraft Materials and Process Engineers. Fort Worth, Tex. Dec 8-9.

2ND NATIONAL CONFERENCE ON THE APPLICATION OF ELECTRICAL INSULATION, American Inst. of Electrical Engineers and National Electrical Mfrs. Assn. Washington, D. C. Dec 8-10.

6TH NATIONAL SYMPOSIUM ON RELIABILITY AND QUALITY CONTROL, Inst. of Radio Engineers, American Society for Quality Control, Electronic Industries Assn., and American Inst. of Electrical Engineers. Washington, D. C. Jan 11-13.

SOCIETY OF PLASTICS ENGINEERS, INC., 16th Annual National Technical Conference. Chicago. Jan 13-15.

MALLEABLE FOUNDERS SOCIETY, semi-annual meeting. Cleveland. Jan 15.

SOCIETY OF VACUUM COATERS, 3rd annual meeting. New York City. Jan 26-27.

AMERICAN SOCIETY FOR TESTING MATERIALS, Committee Week. Chicago. Feb 1-5.

AMERICAN INST. OF ELECTRICAL ENGINEERS, winter general meeting. New York City. Feb 1-5.

SOCIETY OF THE PLASTICS INDUSTRY, INC., 15th SPI Reinforced Plastics Div. Conference. Chicago. Feb 2-4.

AMERICAN SOCIETY FOR METALS, 1960 Golden Gate Metals Conference. San Francisco. Feb 4-6.

AMERICAN INST. OF MINING, METALLURGICAL, AND PETROLEUM ENGINEERS, annual meeting. New York City. Feb 14-18.

AMERICAN ELECTRICAL INDUSTRIES EXPOSITIONS, INC., 5th National Electrical Industries Show. New York City. Mar 6-9.

STEEL FOUNDERS' SOCIETY OF AMERICA, 58th annual meeting. Chicago. Mar 7-8.

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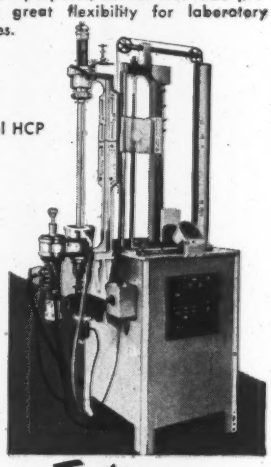
Lepel induction heating equipment represents the most advanced thought in the field of electronics . . . the most practical and efficient source of heat developed for numerous industrial applications.
You are invited to send samples of work with specifications. Our engineers will process and return the completed job with full data and recommendations without cost or obligations

FLOATING ZONE UNIT FOR METAL REFINING AND CRYSTAL GROWING

A new floating zone fixture for the production of ultra-high purity metals and semi-conductor materials. Purification or crystal growing is achieved by traversing a narrow molten zone along the length of the process bar while it is being supported vertically in vacumm or inert gas. Designed primarily for production purposes, Model HCP also provides great flexibility for laboratory studies.

Model HCP



Features

- A smooth, positive mechanical drive system with continuously variable up, down and rotational speeds, all independently controlled.
- An arrangement to rapidly center the process bar within a straight walled quartz tube supported between gas-tight, water-cooled end plates. Placement of the quartz tube is rather simple and adapters can be used to accomodate larger diameter tubes for larger process bars.
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WHEN

...an intricate metal part requires a costly series of machining operations

...small undercut parts are too complicated in shape for powdered metallurgy

...parts are in too critical dimension or finish for sand casting

or, WHERE

...limited volume or high temperature of metal does not permit use of die casting

...metal required is too hard to machine economically

...the shape is too intricate to forge or the section too heavy to stamp

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is the proven way out!

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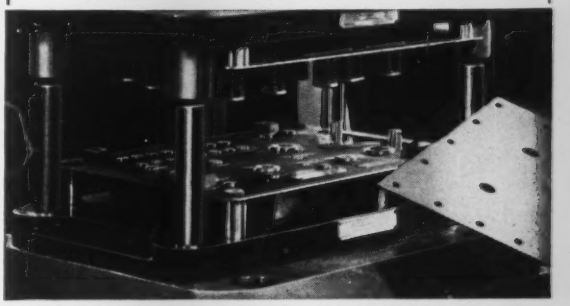

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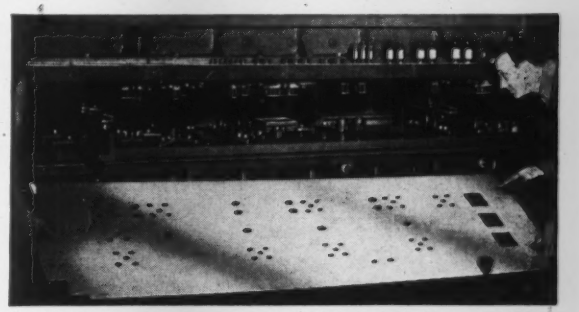

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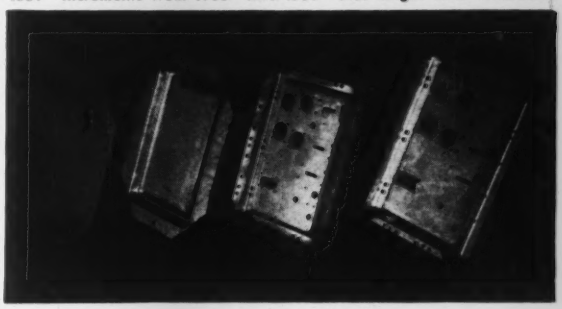

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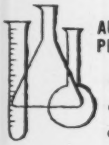

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TECHNICAL LITERATURE *(cont'd from p 49)*

Books

Source Book of the New Plastics: Volume 1. *Edited by H. R. Simonds. Reinhold Publishing Corp., New York. 1959. Cloth, 6 by 9 in., 360 pp. Price $10*

This book gives properties, uses, fabrication and design data, and prices of seven new plastics introduced during the past two years. The new plastics include: 1) acetal, 2) polypropylene, 3) methylstyrene, 4) polycarbonate, 5) ethylene oxide, 6) polyacrylamide, and 7) chlorinated polyether resins.

The book also describes the significant recent improvements in established plastics, and the 100 most important patents issued in the plastics field for 1958. It contains the first and only survey of federal sponsored research in plastics.

The book is illustrated with tables, photographs and drawings.

Metallizing Handbook: Volumes 1 and 2. *H. S. Ingham and A. P. Shepard. Metallizing Engineering Co., Inc., Westbury, N. Y. 1959. Cloth, 6 by 8½ in., 345 pp. Price $5*

Tells how to use the metallizing process. Gives information on corrosion and oxidation resistant coatings, new automated spraying equipment, machine maintenance, ventilation and safety measures, production techniques and spraying speeds. The book is divided into two parts. The first part covers the wire process and the second part the powder process for flame spraying metallic and ceramic coatings.

Property Measurements at High Temperatures. *W. D. Kingery. John Wiley & Sons, Inc., New York. 1959. Cloth, 7 by 10½ in., 428 pp. Price $16.50*

Discusses factors affecting the properties of materials and their measurement at temperatures above 2550 F. All important high temperature properties are discussed, including heat conduction, thermal expansion, strength, elasticity, electrical and magnetic properties, and surface energy.

The Flow of Steel in Molds. *Steel Founders' Society of America, Cleveland, Ohio. 1959. 120 pp. Price $3.50*

Series of lectures discusses: 1) fundamental principles of the flow of liquids, 2) fluid dynamics of the flow of steel, 3) fluidity of steel and its importance in the flow of steel, 4) the flow of steel in runners, ingates and sprues, and 5) influence of gating on steel casting quality.

Soviet Physics—Crystallography: Volume 2. *American Institute of Physics, New York. 1959. Price $25*

English translation of all issues of the Russian magazine *Crystallography* published during 1958. The journal offers both experimental and theoretical papers on crystal structure, lattice theory, diffraction studies, and the effects of external influences (including radiation damage) on crystalline structures.

(Reports on p 218)

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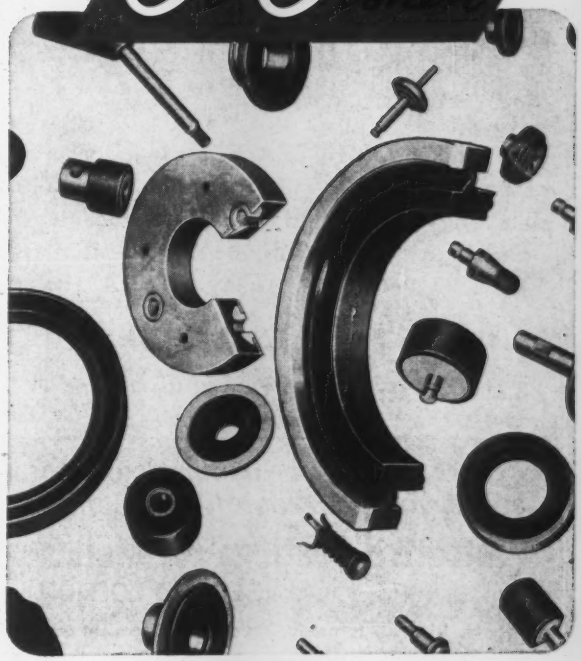

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TECHNICAL LITERATURE

Reports

Titanium sheet alloy. DEVELOPMENT OF A HEAT-TREATABLE TITANIUM SHEET ALLOY. *C. R. Lillie and D. W. Levinson, Armour Research Foundation. Aug '58. 92 pp. Available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C. Price $2.25 (PB 151279)*

Describes a titanium-aluminum-molybdenum-beryllium sheet alloy with a yield strength of 160,000 psi at room temperature.

Radiation reflective coatings METAL PROTECTIVE AND RADIATION REFLECTIVE CERAMIC COATINGS. *C. L. Hoenig, T. A. Willmore and D. G. Bennett, University of Illinois, Engineering Experiment Station. Jan '58. 33 pp. Available from Library of Congress, Photoduplication Service, Publications Board Project, Washington 25, D. C. Price $3 (microfilm), $6.30 (photocopy) (PB 137571)*

Study shows that a calcined ceria refractory coating has good radiation reflection properties. The ceria coating functioned effectively in a one-coat application on type 347 stainless steel when used with a matrix glass of proper thermal expansion.

Wrought beryllium alloys DEVELOPMENT OF WROUGHT BERYLLIUM ALLOYS OF IMPROVED PROPERTIES: PART 1. *J. G. Klein, L. M. Perleman and W. W. Beaver, Brush Beryllium Co. Feb '59. 154 pp. Available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C. Price $3 (PB 151711)*

Describes research to obtain an alloy or structural modification of beryllium that can be rolled, extruded and subsequently fabricated into aircraft and missile components more readily than metal of commercial purity. Some of the conclusions reached: 1) preferred crystallographic orientation improves tensile properties in the direction of work; 2) recrystallization and grain growth must be avoided in cross rolling from extruded bars; and 3) beryllium produced from subsieve size powder and high oxide powder can be used to obtain wrought metal with tensile properties superior to those of commercial-grade metal.

Embrittlement of plated springs HYDROGEN EMBRITTLEMENT OF PLATED STEEL SPRINGS. *J. A. Gurklis, L. D. McGraw and C. L. Faust, Battelle Memorial Institute. Dec '58. 45 pp. Available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C. Price $1. 25 (PB 151125)*

Acid resistant paint DEVELOPMENT OF A FUMING NITRIC ACID RESISTANT PAINT. *M. H. Sandler, Aberdeen Proving Ground, Coating and Chemical Laboratory. Sept '58. 13 pp. Available from Library of Congress, Photoduplication Service, Publications Board Project, Washington 25, D. C. Price $2.40 (microfilm), $3.30 (photocopy) (PB 136731)*

A satisfactory paint based on chlorosulfonated polyethylene was prepared and found to have excellent resistance to red fuming nitric acid.

Acoustic fatigue of aluminum A STUDY OF THE ACOUSTIC FATIGUE CHARACTERISTICS OF SOME FLAT AND CURVED ALUMINUM PANELS EXPOSED TO RANDOM AND DISCRETE NOISE. *R. W. Hess, R. W. Herr and W. H. Mayes, Langley Research Center. Aug '59. 41 pp. Available from National Aeronautics and Space Administration, Washington, D. C. (D-1)*

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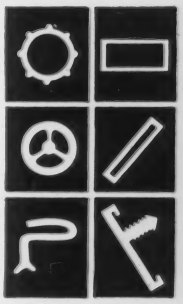

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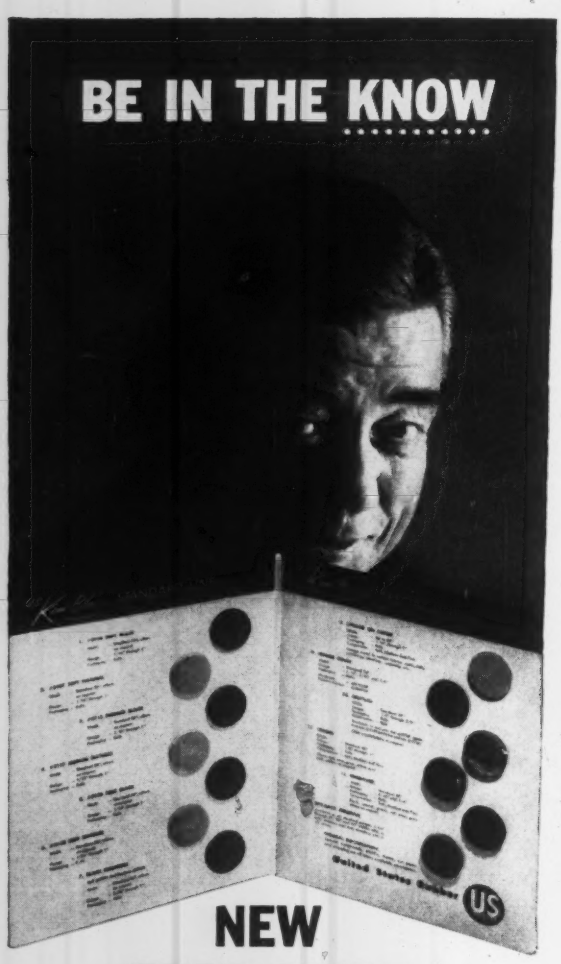

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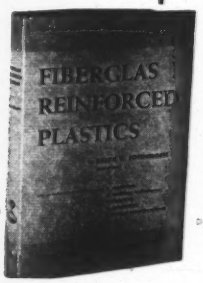

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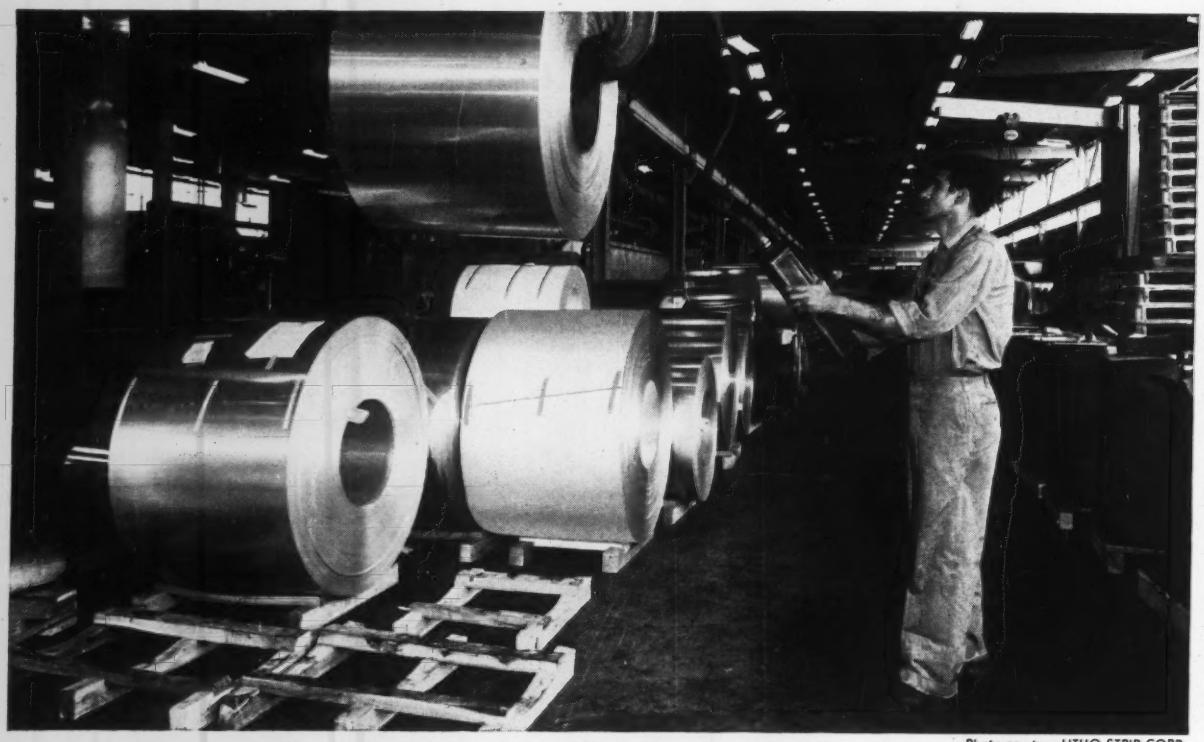

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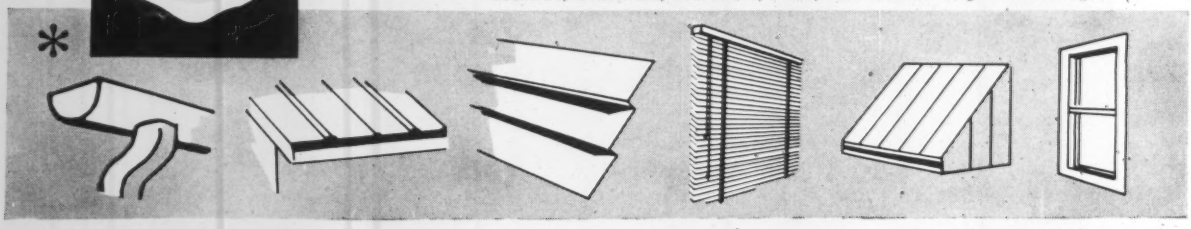

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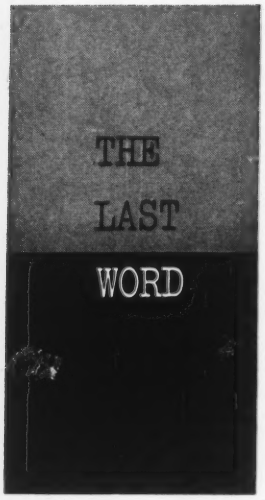
Metallurgy or Materials Engineering?

There is room for both



by ***H. R. Clauser***
Editor

Over the years we have urged that more engineering schools establish four-year courses in materials engineering. The last time was in this column in the July '58 issue (p 83). We pointed out then that there is a growing need in industry for men with a thorough knowledge of the engineering properties and the processing characteristics of *all* materials.

We will always need metallurgists

Although many in industry and education favor moving more rapidly in this direction, there is still considerable opposition among educators. Much of this opposition, we believe, stems from a fear that materials engineering will supplant metallurgical engineering in the schools and as a professional discipline.

But there are no strong reasons why this should or will happen. There will always be a need for metallurgists. Finding better, lower cost ways of producing volume metals is certainly necessary to the continued advance of our technology. Likewise, developing extractive and melting techniques for producing higher quality metals and for producing the "newer" metals at reasonable cost is one of the biggest challenges to the metallurgist today. And in the field of physical metallurgy, as well, there is no end to the problems specifically related to metal structure, properties and treatment. These are the activities that are traditionally in the sphere of metallurgical engineering, and they will remain there.

New discipline has broader domain

Materials engineering, although in many ways related to metallurgy, is really a new field —a new discipline—that by and large is extending into areas outside the metallurgist's traditional domain. Most of these areas lie in the materials-using fields where new products and revolutionary new devices are being developed that have new and severe service requirements to meet. To meet these parameters, materials properties once considered of little value have suddenly assumed great importance.

And here, as we see it, lies the basic difference between metallurgy and materials engineering. Metallurgical engineering education and practice focuses attention primarily and largely on materials—specifically, the metals. In materials engineering, on the other hand, the point of departure is materials *properties* rather than the materials themselves.

Orientation is toward use, not material

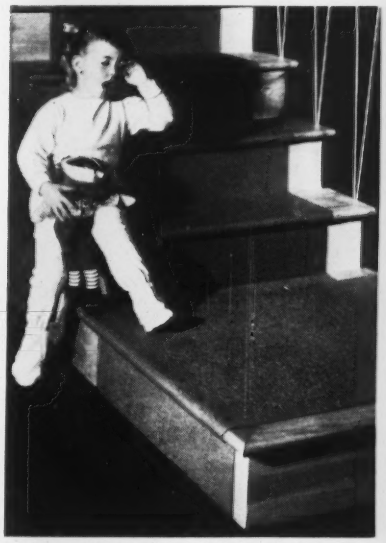
Thus, materials engineering is end-service oriented and the major concern is finding or developing, and applying, a material or materials with the right combination of properties to solve problems. Hence, the emphasis placed on the relation of properties to structure, the interest in not only one but all materials, the imaginative work being done in devising composite materials, and the looking upon materials as systems rather than as monolithic entities.

The few materials engineering textbooks now available further illustrate this basic difference in approach between the two fields. The materials engineering texts are entirely devoted to properties with little reference to specific materials, as contrasted to most metallurgy texts which are organized by kinds of metals.

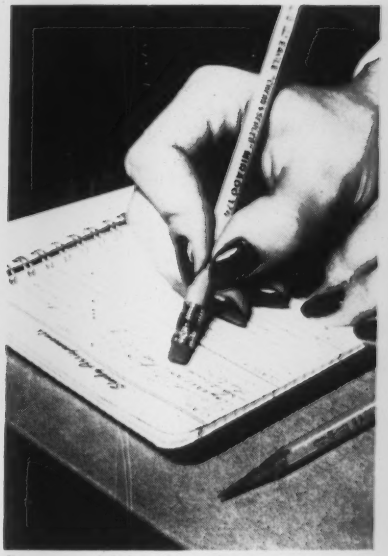
Both approaches are valid

There is much debate going on over these two approaches. But little is to be gained by arguing that one is better than the other. As we have tried to point out, each has its place, each is best in its own area, and there will always be room for both.

Rainwear—colors stay bright



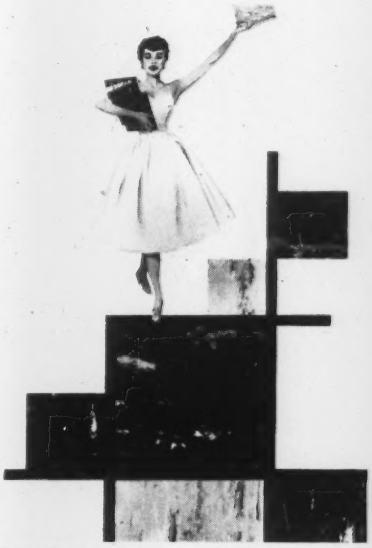
Stair treads—cost less with Ameripol



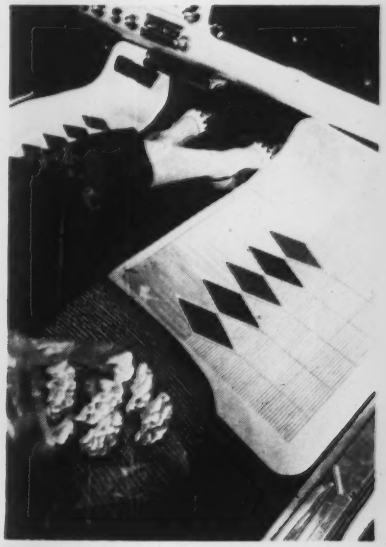
Erasers—mistakes come clean

More and more successful products are being made of **Ameripol Rubber**...the broadest line, from the world's largest source of synthetic rubber...**Goodrich-Gulf**

Shoe soles—easier processing



Floor tile—real comfort underfoot



Car rugs—Ameripol cut costs again

Goodrich-Gulf Chemicals, Inc.

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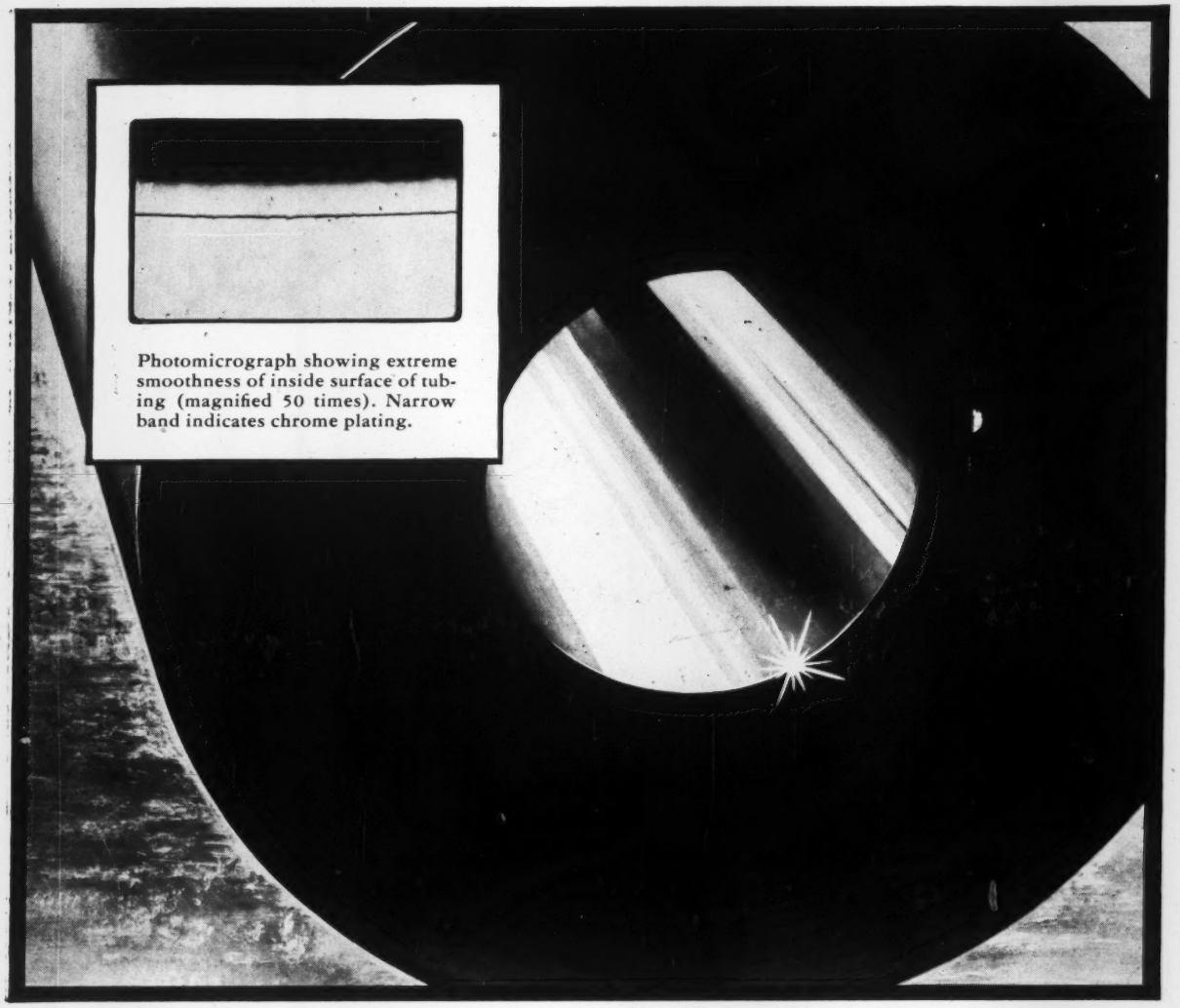

Photomicrograph showing extreme smoothness of inside surface of tubing (magnified 50 times). Narrow band indicates chrome plating.

How to beat fatigue

caused by pulsating pressures up to 50,000 psi

PROBLEM: Manufacturers of polyethylene plastic were plagued by *costly* fatigue failures in the heavy wall, high pressure steel tubing they were using. *Result:* Costly, frequent replacements with attendant production and time losses.

CAUSE: The tubing's inside surface had slight, almost invisible imperfections which gave the pulsating pressures—varying between 35,000 and 50,000 psi—a toe hold for failures to start.

SOLUTION: Timken Company metallurgists recommended a specific low-alloy steel tubing that could be produced with a glossy-smooth interior surface. They used specially developed Timken Company processing techniques, based on more than 40 years of experience with all types of high pressure steel applications. Result—another special steel problem solved.

WHATEVER your special steel problem, it will pay you to use the experience of the experts—metallurgists of the Timken Company. Give us a call the next time you need help. The Timken Roller Bearing Company, Steel & Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO". *Makers of Tapered Roller Bearings, Fine Alloy Steels and Removable Rock Bits.*

TIMKEN® *Fine Alloy* STEEL

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